THURSDAY, JULY 3, 1884

CHOLERA AT TOULON

THE doubt which existed as to whether the outbreak in and about Toulon was true cholera or only the sporadic type of the disease must be regarded as set at rest; indeed, from the date when the details of the outbreak first became public, it is probable that those who declared the affection to be only of a local and sporadic character were mainly influenced by political motives. Dr. Fauvel apparently now stands alone in the determination not to admit that the epidemic is the same as that which is known as Asiatic in type, and the fact that the source of the infection cannot by any chance be attributed to England is almost enough of itself to mould the views of this able physician. The onset of the disease, the sudden outbursts during its subsequent course, its diffusion to other towns and places, and notably to Marseilles, and the fatality attending it, all prove that we have not to do with the disease which in this country goes by the name of English cholera, and which when occurring in hotter climates and under favouring conditions of filth is known as sporadic, but with true cholera, such as was imported into the south of France and into England from Alexandria in 1865 and 1866.

Of the future course of the epidemic it is at this stage almost impossible to speak with any authority, but it is very certain that occasional lulls in the number of attacks—occurrences which are immediately reported as indicating a subsidence in the outbreak—cannot be regarded as having much significance in this respect; for it is one of the essential characteristics of cholera, especially in the early stage of an epidemic, to exhibit periodic fluctuations both in the number and in the intensity of attacks. So, also, the hold which cholera acquires in any town or district is largely dependent on the sanitary circumstances of the locality, and it is well known that in Toulon the conditions of filth which so especially favour the spread of that disease are exceptional in point of general prevalence and intensity. Marseilles stands much higher in this respect, but French towns which are regarded as ranking among the most advanced in so far as their sanitary circumstances are concerned stand but low in the scale when compared with the healthy towns of England.

Another circumstance has rendered it well-nigh impossible to foretell events, and that is the flight of panic-stricken persons to all parts of the country. Instead of dealing with the outbreak in its early stage, the French authorities made a secret of the matter, and by the time that the Government which takes precedence of all others in extolling the virtues of *cordons sanitaires* were prepared to act, they found that their secret had oozed out, and that thousands had fled beyond all *cordons;* and so once again the fear of restrictive measures such as quarantine and its allied practices has defeated the very objects which the advocates of that system so unhesitatingly claim for them.

Bringing the lesson of the epidemic home to ourselves, it must be admitted that, with the constant communication which exists between the various French and English ports, we are not free from the risk of having cholera imported. To prevent importation by imposing a lengthened quarantine on the almost numberless vessels arriving in England from the various French ports would be an impossibility; and our Government, fortified by the decision of the last European Conference held at Vienna, will unquestionably trust, as heretofore, to a combined system of inspection and isolation. For this purpose all the Orders and Regulations which were re-issued during the prevalence of cholera in Egypt last autumn remain in force, as also does the special provision that persons removed to the hospitals of the Metropolitan Asylums Board are not to be regarded as having become pauperised in consequence of such removal. At our various ports vessels arriving from infected places will be inspected, first by the Customs Officers, and then by the Sanitary Officers of the ports; all cases of cholera or choleraic diarrhœa will be at once removed to such hospitals as have been provided for the purpose; any doubtful cases will be detained to undergo a short supervision; the healthy will be allowed to land; and no detention of the ship or of persons on board will exceed forty-eight hours, a period regarded as ample in view of the short period of incubation in the case of cholera.

Last year, when the question of the importation of cholera from Egypt was so urgent, the Local Government Board issued a special Memorandum to port, urban, and rural sanitary authorities, urging them to observe the utmost cleanliness in relation to all sources whence any pollution of water drunk or of air breathed could possibly emanate, and a vast amount of valuable sanitary work was carried out with the object of preserving water-sources from contamination, of excluding sewer and drain air from dwellings, and procuring the rapid and regular removal of all sources of nuisance and offensiveness from premises. We shall this year profit from so much of that work as was of a permanent character; but since it is essentially on cleanliness of all our surroundings that we must rely, the work of 1883 should be continued and renewed this year. Such work is never wasted. Even should cholera die out in the south of France, and never come nearer to us than it has done already, progress in sanitary work will be amply remunerative in the prevention of those diseases which, in point of origin, so much resemble cholera, and it will, in addition, tend to the moral and social improvement of those who only cling to filthy surroundings because the means of cleanliness have never been provided for them.

We are glad to learn that Dr. Koch, the chief of the recent German Cholera Commission to Egypt and India, has left Berlin for Toulon. His journey is undertaken partly at the wish of the French Government, who are anxious to know more of the methods of investigating and suppressing cholera which that gentleman has pursued with such signal success. Dr. Koch is going to France alone, although he had full permission to take with him any of his recent colleagues in Egypt and India. Moreover, the German Imperial Cholera Commission has concluded its deliberations. The result has now been submitted to the Government, and will be immediately published. The Commission holds that the sanitary condition of Germany in general is not favourable

to the outbreak of the epidemic here. Further to lessen the danger, every separate household is to be requested immediately to carry out scrupulously the precautions and orders in reference to disinfection which are to be issued by the Government.

THE EARTH AS A GLOBE

Die Erde als Weltkörper, ihre Atmosphäre und Hydrosphäre, Astronomische Geographie, Meteorologie und Oceanographie. Von Dr. Julius Hann. Pp. 209. (Prag: F. Tempsky; Berlin: G. Freytag. 1884.)

IT sometimes happens that the leading words in the title of a book give a very inadequate impression of its contents. Such, to an English reader at least, might be the case as regards the work before us. We should have rather anticipated a discussion of the relation of our globe to the surrounding universe, or at any rate its position as a member of the great family dependent on the same central source of light and warmth. A compatriot of the writer, it is but fair to suppose, would have formed a juster anticipation of what the title-page expresses and the contents explain, that we have here a description of the earth as an isolated globe. The first section sets before us its form, dimensions, density, seasons, magnetism in its several aspects, and auroral illumination. The following one discusses the various conditions of our atmosphere with regard to temperature, pressure, humidity, rainfall, winds, cyclones, and all that English people express by the brief and usually not complimentary phrase, "the weather." The third section relates to the "hydrosphere," or fluid envelope, comprising its extent, colour, saltness, temperature, currents, waves, and tides. This programme is carried out not only with a great deal of industry, and care, and judgment, but with a clearness and facility of expression which are not always remarkable in scientific treatises. We are very favourably impressed by it as a whole, and look upon it as a very valuable addition to the branch of science which it undertakes to elucidate. At the same time there are a few respects in which improvement might be desirable. We should have preferred, for instance, some explanation of the comparative imperfection of the longitude-measures obtained from Jupiter's satellites, as well as from lunar distances; the aëronautic details might have borne expansion with advantage; and we are a little disappointed in the very scanty notice of atmospheric electricity. Of this it may indeed be said that its investigation is peculiarly difficult, and that many of its modifications hitherto defy explanation; but it would have been, we venture to think, a preferable course, especially as so much pains have been taken with magnetism, if more explicit reference had been made to an influence of so powerful, yet so occult and mysterious a nature.

We may add, though we are treading on uncertain ground, that our author's descriptions of the English climate, or rather of what he considers that it ought to be, with regard to dryness or the reverse, are not altogether in agreement with our own experience. The character of our month of February, as expressed in the very ancient and still surviving epithet, "fill-dyke" (or "fill-ditch"), or in an old rhyme of the seventeenth century—

> "Foul weather is no news, hail, rain, and snow
> Are now expected and esteem'd no woe,"—

does not tally well with our author's estimate of January as the most rainy of months, at least in West England; and his description of October as having a full maximum of rain in East and a secondary maximum in West England matches as little with the traditional remark of half a century ago, that eighteen fine days always occur in that month. Nor again is the April of West England, as he asserts, characterised by dryness, which used to be predicated of March, together with, in our grandsires' remembrance, a degree of heat which caused the unyoking of the weary ox during the noontide hours; so that we find in these instances the anticipation or postponement of a month. Our ground however is, as we have said, somewhat insecure; and we are obliged to admit that our old-world remembrances are often as far out of keeping with our present experience as the theoretical deductions of Dr. Hann. The October of late years has certainly not maintained its reputation for fineness, and we miss the regularity as well as the intensity of the equinoctial gales. There is an element of uncertainty and instability not only in the daily or monthly condition of the weather but in its annual recurrence, at least as far as our own climate is concerned; and it has presumably a much wider extent: a similar remark is not unknown in Switzerland, and was confirmed as to North Italy by the disappointing experience of that most accurate astronomer, Baron Dembowski, who in his latter years had, as he informed the writer of these lines, to contend with an unwonted amount of unfavourable skies. Such variations may possibly be very slowly periodical, and, if so, their recurrence might well be the subject of a careful examination. The weather-lore of modern days is undoubtedly far in advance of the imperfect forecasts of a century ago, and the pages before us have done well in aid of its further progress; but experience shows that the science of meteorology requires to be set upon a deeper and stronger foundation. The neglect of one or more imperfectly appreciated factors is probably indicated by the uncertainty or inconsistency of the results. One such factor may readily be pointed out in electrical agency, latent on every side, but awakened from time to time in manifestations equally fearful and incomprehensible. How to take due account of this all-pervading influence is a problem for future generations.

In closing our brief notice of this valuable work we would especially allude to the especial clearness—with few exceptions—of the very satisfactory as well as numerous diagrams which illustrate it. So far as we have observed, the faults of the book are very few: the greatest, as far as English students are concerned, is one that may easily be rectified, and we trust soon will be—its appearance in a foreign tongue.

PRACTICAL BOTANY

Das botanische Practicum. Von Dr. Eduard Strasburger. (Jena: Gustav Fischer, 1884.)

THE production of a series of important works in rapid succession has pointed out Prof. Strasburger as one of the most prominent figures among botanists of the present century. It will be readily

seen from the character of his researches, which deal for the most part with questions of minute structure and development, that he combines unusual power of close observation with originality of treatment and wide knowledge of methods. These qualities, together with a clear style of exposition, are those most needful for the production of a handbook for the guidance of students in the botanical laboratory; and the result does not disappoint the expectations of those who have been awaiting the appearance of Prof. Strasburger's volume.

The 600 pages of which the book consists are printed partly in large, partly in small, type, the former being intended for the beginner, the latter for the use of more advanced students. The whole is divided into thirty-four lessons, corresponding to the number of practical demonstrations habitually given in the course of one semester in a German University. But, as the author freely admits in his preface, it is not assumed that a detailed study of the objects named in one lesson could be made in the time during which one demonstration lasts; it is, however, stated that the time would usually suffice to give the student a general idea of the most important points. With due deference to Prof. Strasburger, in this admission lies the weak point in the book; if such a system as this be adopted with students on their first entrance into the botanical laboratory, and if the work be so presented to them that it should appear to them desirable rather to hurry through the study of a number of objects than to pay closer attention to a few, the result would naturally be the encouragement of a superficial style of observation; this method is not at all consistent with that usually adopted by German professors, and our experience as teachers on this side of the Channel does not lead us to approve of it. If, however, the student be not limited in respect of time, he would by carefully and successfully working through the course, both of large and small type, laid down for him, find himself at the end of it an accomplished laboratory botanist, well fitted to strike out a line of research for himself.

After giving a short introductory description of the microscope itself, and a list of makers and prices, Prof. Strasburger leads the student on by gradual steps, from the observation of starch-grains and their reactions, to the more complete study of the cell, with its included bodies, special attention being paid to the plastids and their various modifications. Having thus become acquainted with the general morphology of the cell, he is introduced to the study of tissues, the epidermis with its appendages being taken first, and subsequently the vascular bundles and surrounding tissues, as seen successively in the axis, root, and leaf; the constituent elements of these several tissues in the mature condition are made the subject of detailed observation. It is to be remarked, however, that little attention is paid to the comparative study of the *course* of the vascular bundles in the shoot, and the methods of its investigation; it is true that on pp. 282-303 this subject is dealt with in small type, but even there the treatment is almost entirely confined to the modifications of arrangement at the point of transition from stem to root; thus the student who works through the large type only will gain a very complete knowledge of the details of structure of the vascular bundle in various types of plants, while his knowledge of the arrangement of the whole bundle-systems in those plants may be very limited.

This course of study of the tissues of the vascular plants in the mature condition having occupied eighteen chapters, the 19th and 20th are devoted to a comparative investigation of the structure of growing points of stems and roots, and the development of tissues, while later chapters deal successively with the structure of the vegetative organs of the Mosses and of various forms among the Thallophytes. In Chapters XXIV.–XXXII. Prof. Strasburger treads upon ground which is peculiarly his own, and brings before the student in succession various examples illustrating the reproductive processes in plants, starting from the lower forms, and proceeding to those of higher organisation. In the concluding chapter he illustrates the processes of nuclear- and cell-division by means of examples already familiar to those who have followed his brilliant researches in this quarter.

The whole book thus forms a compendious and, including the small type, a very complete course of instruction for the student in the botanical laboratory. Throughout the text ample information is given as to methods of treatment, and the use of reagents; and this information is drawn together and made accessible by means of a special index (No. III.). Of the other indices, which form a most valuable addition to the work, the first refers to the names of the plants investigated, and the second to the instruments used, while, finally, No. IV. is a general index to names, reagents, and apparatus.

Prof. Strasburger has treated the question as to the advisability of placing drawings of the objects under investigation before the student in the laboratory in a truly characteristic manner. He has illustrated his book by 182 woodcuts, all of which have been specially prepared for this work. Whatever may be our views as to the effect of the use of such figures on the student, these, being drawn in Prof. Strasburger's well-known style, constitute in themselves a most welcome addition to the figures hitherto published.

There can be no doubt that among senior students and teachers this book will be appreciated as its great merits deserve; and that it will henceforward be an indispensable item in the furniture of the botanical laboratory. But, as may be gathered from what has been said above, it is no book for the cramming student; time must be allowed, and even more time than its author seems to realise, if full advantage is to be reaped from the course laid down. For this reason it is to be feared that it will not be so popular among our junior students as with those who are in a position to judge better of its value. F. O. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Chalk and the "Origin and Distribution of Deep-Sea Deposits"

In a letter of Mr. Starkie Gardner's in the last number of NATURE (p. 192), he stated that my opinion as to the Chalk

having been a shallow-water deposit was "based exclusively on the present habits of the very few genera of Mollusca that have survived from the Chalk period, and seems quite in contradiction to the far more important groups, the Sponges, Echinodermata, and the minute organisms of which the formation is so largely composed, while no opinion has yet found its way into the hands of geologists regarding the depth of water indicated by the Crustacea and the fishes of the Chalk." Mr. Gardner appears to have overlooked that passage in my Address to the Biological Section of the British Association (to which he refers in his letter), wherein I added, "Mr. Woodward tells me that the Chalk Crustacea are shallow-water forms." Dr. Woodward is certainly no mean authority on fossil Crustacea. As to the surviving genera of Chalk Mollusca being "very few" in number, I would refer him and my readers to the long list of genera given in my Address, which was furnished by our great palæontologist, Mr. Etheridge, and to the exclusively littoral habits of some of those genera. And with respect to the Sponges, Echinodermata, and minute organisms being "far more important groups" than the Mollusca, I must leave that question to naturalists in general. Sponges (silicious as well as horny or ceratose), and Echinoderms are notoriously not restricted to deep water. Quite the contrary. They live at every depth from the shore between tide-marks to the abyssal and benthal zones. The "minute organisms" which enter so largely into the composition of the Chalk, for the most part, if not entirely, inhabit the surface of the sea. J. GWYN JEFFREYS

June 30

Protoplasmic Continuity in Plants

IN the very interesting article on "The Continuity of the Protoplasm through the walls of Vegetable Cells," which appeared in NATURE of June 19 (p. 182), reference is made to the doubt which still exists as to "whether the continuity is maintained from the earliest stages, or is established later." This point is so important in its physiological bearings, as the article goes on to show, that I may, perhaps, be allowed to state that, with regard to one group of plants, the question appears to be already settled. I allude to the Red Sea-weeds or the *Florideæ*. The writer of the article makes no mention of these plants, but, as I have described elsewhere (see *British Association Report*, 1883, p. 547, and *Journal of Botany*, February and March 1884), many of them exhibit a very notable system of intercellular connections, which, extending over the whole thallus, renders the protoplasm practically continuous from the base of the frond to the extremities of its furthest ramifications. Now in these cases the continuity is certainly maintained from the first, and is due to the mode of cell division by which the thallus is built up. Into the details of this there is no need to enter further than to say that, when the protoplasmic body of a cell divides into two or more portions, these do not become completely separated from one another, but remain connected *inter se* by strands of protoplasmic material, which grow in thickness with the growth of the cells, and thus maintain the continuity from the earliest stages onward. So far, then, as concerns the *Florideæ*, I venture to think the physiological import of the phenomena of continuity may be safely discussed on the assumption of its existence *ab initio*. What that import may be I do not propose to consider, my object being simply to point to the *Florideæ* as throwing valuable light on the whole subject, and giving some support to the view that "the entire plant or organ is practically one whole—one mass of protoplasm cut up into chambers which communicate with one another, and bounded by a membrane on the exterior." THOMAS HICK

Aseismatic Tables for Mitigating Earthquake Shocks

WITH respect to Mr. C. A. Stevenson's letter in your last issue (p. 193), I may state that my information was obtained from Mr. R. H. Brunton's paper on "The Japan Lights" in *Proc. Inst. Civ. Eng.*, vol. xlvii., pp. 6-8, 35, and from the communication by Messrs. Stevenson in the "Discussion" on that paper (pp. 26-29). The results referred to by Mr. Stevenson have, perhaps, been obtained since this paper was read (November 14, 1876). W. TOPLEY

28, Jermyn Street, London, June 27

Black Rain

A REMARKABLE shower of black rain fell here and in the neighbourhood last Sunday, the 22nd inst. The forenoon had been fine, though somewhat hazy, but about 3.30 p.m. heavy cumuli formed to north and north-west. Gradually a dense mass of cloud and haze came from the northward, presenting a lurid, threatening aspect, and it become so dark that one could not read a book indoors. At 4.30 rain began to fall, at first a few drops, and soon after a heavy downpour. When this commenced I noticed a number of black objects floating in the air, which I at first took to be flies or winged ants, but they rapidly increased in number, and on looking at them more closely I found them to be particles of soot, on an average about the size of the common fly. Their number was so great that, it appeared for ten minutes to be snowing black, the descent of the blacks being slow, like that of snowflakes. After it had rained heavily for fifteen minutes, these "blacks" ceased and the air became lighter, but the rain continued for another hour, and altogether I measured ·30 inches in my gauge. I find on inquiry that this black rain was noticed in the whole neighbourhood—at least four miles to the north-east and two miles to westward, hence it cannot have been due to local chimneys. As far as I can ascertain, the shower was entirely local; it seems to have followed a narrow course from north to south only a few miles wide, and did not extend to either Eastbourne or Hastings.

Fletching, Sussex, June 24 W. J. TREUTLER

A Cannibal Snake

RATHER a strange occurrence came recently before my notice, and thinking perhaps you might care to insert it in your columns, I send you the facts of the circumstance. A few days since, towards evening, I killed a snake just close behind my house; it measured about a yard and a half in length, was one of the most deadly of the numerous kinds of snakes found in Java, and bears the name of "Oelar belang." On examining it later I found what I thought to be the tail of another small snake protruding from its mouth, but on pulling it out I was greatly surprised to discover that it was really a snake of the same species, and of almost the same length. There was certainly not more than three inches' difference in the length of the two snakes, and at the time I killed the outside snake only about an inch and a half or two inches of the tail of the one he had swallowed protruded from his mouth. The outside snake was of course considerably the thicker of the two, but this may be attributed to his having swollen after, or rather during, his tremendous meal. The natives here say that the two snakes must have been fighting, the victor afterwards swallowing his opponent. I should be pleased to know whether such an instance has ever before been brought before your notice, or whether it is really an uncommon case. EDWIN H. EVANS

Soemedang, Java, May 20

Peronospora infestans

ON the 22nd inst. I observed that this fungus had appeared on the haulm of the potato crop in one or two places in my garden in this city. On examining to-day a potato crop in another garden a mile distant from mine, I perceived that that crop was likewise affected. Considering the dryness of the spring weather, the appearance of the disease is remarkable. According to my observation, the attack of the mould is a month earlier than usual. It may be added that hereabouts, this season, blight of all kinds is prevalent, while last year was blight free. Inclosed is a specimen of diseased haulm. J. LL. BOZWARD

Worcester, June 24

KEPHIR

IN No. 10 of the *Journal of the Berlin Chemical Society* for June 23 is a communication on this substance by M. Struve of Tiflis, continued from a previous note in the same journal of February 25.

Kephir is a form of fermented milk which has been prepared and in use amongst the inhabitants of the Northern Caucasus for a great length of time, and occupies with them a similar position as an article of diet and medicine to that of kumis in the south-eastern steppes of Russia.

Kumis was first brought into notice in 1784, and has since then been pretty fully investigated and taken a definite position, but kephir has only been generally

known even in Russia for about two years, although several notices of its medicinal properties have been contributed to the Caucasian Medical Society. The knowledge and spreading use of this new drink in Russia dates apparently from an investigation and paper read on this new ferment product by E. Kern at the Moscow meeting of the Imperial Naturalists' Society in 1881.

Kephir is prepared by fermenting milk, either sheep's, goats', or cows' milk, with what are termed kephir-grains, the process taking place in leather bottles (*Burdinks*). These grains are the ferment proper, the leather bottle not being supposed to be absolutely necessary. During the fermentation the milk becomes very much changed, and at the same time there is a reproduction of the ferment substance or kephir-grains, which is removed after a certain stage of fermentation has been reached, and after drying in the sun may be preserved, and serves again to effect the fermentation process. Nothing is known of the origin of this peculiar ferment. An analysis of the grains dried at 100° C. gave:—

Water	11·21
Fats	3·99
Soluble peptone substances	10·98
Proteids soluble in ammonia	10·32
,, ,, potash	30·39
Insoluble	33·11

The insoluble residue exhibited under the microscope an intimate mixture of yeast-cells, and the *Bacterium dispora caucasica* with a few Leptothrix and *Oidium lactis* possibly as accidental. This 33·11 per cent. of insoluble matter seems to be the only active part of the kephir grains. On preparing some kephir in bottles with this, the product became slightly effervescent after twenty-four hours, and contained a small amount of alcohol. After three days the amount of alcohol and carbonic acid was much increased. On making an examination of the fermented liquid after one, two, and three days respectively, the quantity of casein found was practically the same in each case. But on treating the casein so obtained with dilute ammonia and then dilute potash solution, in no case was there a complete solution. An amount of insoluble residue was obtained from the *third-day* experiment of ·22 per cent. of the casein, and which consisted entirely of yeast-cells. From this is concluded that the fermentation of the milk is entirely due to *Saccharomyces mycoderma*, the *Bacterium dispora caucasica* not taking any part in the fermentation, and this seems to be further supported by the fact that the "finished" drinkable kephir will start fermentation in fresh milk in the same manner as the kephir-grains.

The *Bacterium "dispora"* which Kern noticed, and to the action of which he ascribed the peculiar properties of kephir, probably results, in quite a secondary manner, from the employment by the people in the Caucasus of the old leather of the bottles in which kephir has been fermented. In this process in leather bottles the yeast-cells are in contact with the leather, and to some extent possibly grow or extend into it, so that they become modified physically, and the rapidity of fermentation is much lessened. Any animal tissue which has become, as it were, saturated or penetrated by yeast-cells is capable of causing sugar solutions and also milk to ferment, and can therefore be used in place of these kephir-grains for the preparation of kephir.

HENRY WATTS, F.R.S.

WE regret to announce the death of Mr. Henry Watts, F.R.S., the well-known chemist; he died on June 30, of syncope from failure of the heart's action, after a very short illness.

Henry Watts was born in London on January 20, 1815. He was educated first at a private school in London, and subsequently attended lectures at the University College, London. In 1841 he graduated as Bachelor of Arts in the University of London. In 1846 he entered the Birkbeck Laboratory of Chemistry, then recently established at University College, as assistant to his highly valued friend, the late Prof. Fownes, and in that capacity was engaged in directing the work of the students till the death of Prof. Fownes in 1849, and afterwards till 1857 under Prof. Williamson. In 1848 he was engaged by the Cavendish Society to prepare a translation, with additions, of the great "Handbuch der Chemie" of Leopold Gmelin, a work which extended to eighteen volumes, and occupied a large portion of his time for more than twenty years, the last volume and the index having been published in 1872.

In 1858 he began to prepare a new edition of "Ure's Dictionary of Chemistry and Mineralogy"; but finding that this book, the last edition of which appeared in 1831, had fallen too much behind the existing state of chemistry to be made the groundwork of a dictionary adapted to the requirements of the time, he undertook, with the consent of the publishers, and the assistance of a staff of contributors distinguished for their attainments in different branches of physics and chemistry, the compilation of a new "Dictionary of Chemistry and the Allied Branches of other Sciences." This work, in five large octavo volumes, was completed in 1868; but as additions were required to keep it abreast of the continual advances of science, a supplementary volume was published in 1872, a second supplement in 1875, and a third (in two parts) in 1879 and 1881.

Mr. Watts brought out three editions of "Fownes's Manual of Chemistry," viz. the tenth, published in 1868, the eleventh in 1872, and the twelfth in 1877, and also part 1 of a thirteenth, in 1883.

He held for many years the appointments of editor of the *Journal*, and librarian, to the Chemical Society, having been appointed to the former in 1850, and to the latter in 1861. He was elected a Fellow of the Chemical Society in 1847, a Fellow of the Royal Society in 1866, and a member of the Physical Society in 1879. He was also an Honorary Member of the Pharmaceutical Society, and a Life Governor of University College.

He was engaged at the time of his death in writing a new and abridged edition of the "Dictionary of Chemistry"; he was also editing, in conjunction with Mr. C. E. Groves, a re-issue of "Knapp's Technology," and the thirteenth edition of "Fownes's Manual of Chemistry," of which the second volume is left in manuscript.

GEOLOGY AT THE BRITISH ASSOCIATION

THE arrangements for the Geological Section of the British Association are now well advanced, and some idea may be formed of the amount of work likely to be done. Several meetings of the Organising Committee have been held in London, at some of which Principal Dawson has been present. From the list of members of the Association to whom vouchers for the meeting have been issued we learn that English geology will be represented at Montreal by six professors—those of Edinburgh; Trinity College, Dublin; University College, London; Victoria University, Manchester; and University College, Nottingham; and by Prof. T. R. Jones. The Geological Society sends sixty of its Fellows, including the President, Secretary, and six other Members of Council. Many of the leading geologists of Canada also are Fellows of that Society. The Geological Survey sends six of its members, and six or more who have at one time been on the staff.

The President of the Section is Mr. W. T. Blanford, Secretary of the Geological Society, who will afterwards represent that Society at the Philadelphia meeting of the American Association; the Vice-Presidents are Prof. T.

R. Jones and Mr. A. R. Selwyn; the Secretaries are Dr. G. M. Dawson, Messrs. F. Adams, W. Topley (Recorder), and W. Whitaker.

The International Geological Congress meets at Berlin in September, and this will prevent many Continental geologists from going to Montreal; Dr. Richthofen, however, will probably be present, and will communicate a paper on some comparisons between the geology of China and North America. It is hoped that others may also arrange to come.

Meeting in the typical Laurentian country, it is only to be expected that the Archæan rocks will receive much attention. Amongst the papers sent or promised are the following:—Prof. Bonney, on the Lithological Characters of the Archæan Rocks in Canada and Elsewhere; Mr. Frank Adams, on the Occurrence of the Norwegian "Apatitbringer" in Canada, with a few Notes on the Microscopic Characters of some Laurentian Amphibolites; Dr. T. Sterry Hunt, on the Eozoic Rocks of North America.

On Palæozoic Geology and Palæontology generally the following are expected:—L. W. Baily, on the Acadian Basin in American Geology; E. W. Claypole, the Oldest Known Vertebrates—an Account of some Fossils recently discovered in the Silurian Rocks of Pennsylvania; Mr. J. H. Panton, of Winnipeg, Geological Gleanings from the Outcrops of Silurian Strata in the Red River Valley, Manitoba.

Principal Dawson will give a Comparison of the Palæozoic Floras of North America and Europe, whilst Mr. J. S. Gardner will deal with the same subject as regards the Cretaceo-Tertiary Floras.

Other papers are:—G. F. Matthews, on the Geological Age of the Acadian Fauna, and on the Primitive Conocoryphean; E. Wethered, the Structure of English and American Coals.

After the Azoic and Palæozoic rocks of Canada, the Drift Deposits are of great interest. The following papers bear on this subject:—Mr. A. R. Selwyn, on a Theory of Ice Action in the Formation of Lake Basins and in the Distribution of Boulders in Northern Latitudes; the Rev. E. Hill, on Theories of Glaciation; F. Drew, on the Thickness of Ice in the Himalayan Valleys during the Glacial Period.

Amongst other papers of interest are:—Prof. Hull, on the Geology of Palestine, giving an account of his recent explorations; Prof. T. R. Jones, on the Geology of South Africa; W. Whitaker, on the Economic Value of Geological Maps, with especial reference to water-supply, illustrated by the Survey Maps of the Chalk area in England.

Papers are also promised by Mr. Arch. Geikie, Dr. G. M. Dawson, Prof. V. Ball, Prof. W. Boyd Dawkins, Dr. C. Le Neve Foster, W. Carruthers, H. Bauerman, E. Gilpin of Halifax, N.S., and others.

Other papers will be sent by American and Canadian geologists, particulars of which have not yet been received. Prof. James D. Dana and Dr. James Hall, if not present in person, will probably send one or more communications.

Several Reports will be submitted by Committees, or by persons appointed for this purpose at the last meeting of the Association (the name mentioned is that of the Secretary to the Committee, or the Reporter):—Prof. J. Milne, Earthquakes in Japan; W. Cash, Fossil Plants of Halifax; G. R. Vine, British Fossil Polyzoa; Dr. H. W. Crosskey, Erratic Blocks of England, Wales, and Ireland; Prof. T. R. Jones, Fossil Phyllopoda of the Palæozoic Rocks; C. E. De Rance, Underground Waters; J. W. Davis, Raygill Fissure, Yorkshire; C. E. De Rance and W. Topley, Erosion of Sea-Coasts of England and Wales; F. Drew and Prof. A. H. Green, the Present State of Knowledge respecting the Interior of the Earth; W. Whitaker, Geological Record; W. Topley, National Geological Surveys; and Progress of the International Geological Map of Europe.

With several sections of the Association the work is mainly confined to the meeting room. Geologists are more fortunate, their most pleasant memories of these meetings are with the hills, rocks, and streams of the district. At and near Montreal there is much to be seen. Mount Royal rises steeply behind the city, a mass of eruptive rock intruded through the Silurian beds. From the summit a grand view is obtained over the Laurentian Mountain on the north, and over the hills and rolling plains of Silurian rocks on the south and east. From amongst these latter rise the more sharply defined trap hills of Montarville, Beloil, and Rougemont. The excursions are of especial geological interest. Niagara is only a short run of 300 miles away; the Rocky Mountains will be reached by a special train over the Canadian and Pacific Railway.

The Local Committee at Montreal is preparing a guide-book to the city and neighbourhood, which will contain a geological map. A general Geological Guide to the Dominion will be prepared by the Geological Survey of Canada.

PRIMARY EDUCATION AT THE HEALTH EXHIBITION

THE recent opening of the City and Guilds of London Institute by the Prince of Wales, and the simultaneous issue of a special catalogue of the educational exhibits at the Health Exhibition, which are for the most part housed in that Institute, has been the means of drawing much public attention to this most interesting and valuable collection, and renders some account of it opportune. It is probably not too much to say that no such elaborate and extensive collection of educational appliances, methods, and results, has ever been brought together before, notwithstanding the fact that, the primary object of the whole Exhibition being to elucidate the conditions of health, it was considered expedient to attach to the principal display mainly such objects and appliances as had a special relation to healthful school life. This limitation, however, has been interpreted somewhat liberally, and the result is a collection in which can be studied and compared the educational systems in primary, general, and technical education as practised in the British Islands, France, and Belgium, and to a less extent in Germany, Sweden, Switzerland, the United States, and Canada. It is earnestly to be hoped that such an opportunity for comparing their own systems, practice, and results with those of others, whether English or foreign, will not be allowed to pass by our schoolmasters and schoolmistresses, as well as by members of School Boards, and indeed by all interested in this vast subject. We hear with pleasure that it is intended to organise visits there by parties of London masters and mistresses, and we hope that arrangements will be made enabling provincial educationalists to avail themselves of the advantages offered by this temporary display at South Kensington, which will not be prolonged beyond the middle of October.

Two foreign Governments, those of France and Belgium, have organised elaborate collective exhibitions, showing the methods and results both of primary and secondary education in those countries, and the catalogue of the French exhibit is prefaced by ten closely printed pages containing an admirable summary of the present position of education in France, which has of late made most rapid advances. The money which neither the Liberals of the Restoration, nor those of the Monarchy of July, nor the *Corps Législatif* of the Second Empire, had been able or willing to find for popular education, the Parliament of the Third Republic, definitely consolidated in 1877, has not feared to demand of the State, notwithstanding the pressure of taxes resulting from the foreign

and civil war of 1870. In 1882-83 there were 5,432,151 pupils, and 129,657 public teachers (of whom only 21,781 were uncertificated) in the elementary primary schools of France, and the general outlay of the State for primary education amounted in the same year to 94,881, 942 francs, or about 3,825,000*l*.

While cordially recognising the very great trouble that the Ministers of Public Instruction in France and Belgium have taken to illustrate their respective systems, we must not forget that our Education Department occupies a different and wholly unique position, and hence that the English Government, as a Government, is unable to make a similar display. Our Education Department scrupulously abstains from enforcing particular methods and processes, simply requiring that by some local means, voluntary or otherwise, efficient schools shall be provided, and it then confines itself to the estimation of results and to the distribution of funds provided by Parliament in aid of the local efforts; in a word, its control is indirect rather than authoritative. The intelligent foreigner therefore has to search through the collective exhibits of the great voluntary societies which have so long and so largely influenced English primary education, and also of several of the municipal bodies called into existence by the Education Act of 1870, in order to become conversant with the methods and results of English schools. In the special catalogue for education, each of these bodies which exhibits has taken the opportunity to place on record an account of its aims and history, and of the scope and character of its present work. Such additions to this catalogue, occupying many closely printed pages, render it a very admirable hand-book to the whole subject of education, and add immensely to its value. Among the most interesting and valuable statements of this kind are those issued by (to use the shorter titles) the National Society, the British and Foreign School Society, the Wesleyan Education Committee, the Sunday School and the Ragged School Unions, and the School Boards of London, Birmingham, Glasgow, and Edinburgh.

There is one Society, however, which merits more than a passing notice, since its collective exhibit is not merely one of the most remarkable and interesting in the whole Educational Exhibition, but is also one from which a great deal is to be learnt. It is cosmopolitan in its aims, and exhibits the results of its schools in Belgium, France, England, the United States, Canada, Egypt, and India, although its head-quarters are in Paris. The Institute of the Brothers of the Christian Schools was founded in 1680 by the Venerable Dr. J. B. De La Salle, who was the first to establish primary education in France, and also training colleges for teachers. At present the Institute has nearly 12,000 Brothers, distributed over thirteen countries, directing 1200 schools, with an attendance of about 330,000 pupils, who, we regret to say, are all boys, the Brothers not concerning themselves in any way with the education of girls. The Brothers everywhere follow the same general methods of teaching, while they modify the details according to the custom of the country in which they are, varying their programmes also to meet local requirements and the wants of the times; for example, in their United States schools, where all the boys stay till about sixteen, every boy in the first class learns (1) shorthand writing, (2) the use of the type-writer, (3) the Morse alphabet, since without these acquirements the Brothers are unable to get situations for their pupils. The rooms in the Technical Institute, as well as the space in the Belgian and French Courts devoted to the results of their work, will well repay very careful examination, since only their most leading features can be here indicated. Foremost among these, and bearing distinctly upon a subject recently discussed both in this journal and in the *Spectator*, is their system of models, maps, and atlases for the scientific teaching of geography, which are exhibited by Brother Alexis. These maps were the first hypsometrical maps published in French, and, we believe the first of the kind published anywhere for school use, and are intended to give, by a suitable arrangement of colours, clear notions of the real configuration of the earth's surface. An introduction to their study is afforded by a glass tank, with a very uneven bottom, upon which contour lines are marked; when this is filled to various depths with water, the effects of changes in the relative level of land and sea are clearly and effectively demonstrated. This demonstrative or objective method is the keynote to the system of instruction adopted by the Brothers, and its effect is seen in many instances, notably in the splendid school museums of Annecy (Savoy), Beauvais, Rome, and Marseilles, in which the specimens are all collected by the pupils, and classified by the masters; in the apparatus employed in scientific and handiwork teaching; and in their system of teaching drawing, the results of which, as illustrated by an enormous series of designs, entirely the work of pupils, are almost incredible. The lithographed notes of science lessons distributed to the pupils, and the extensive series of science and other text-books, written in various languages by the Brothers, all deserve close inspection.

The Ministry of Public Instruction in Brussels illustrates most fully the Belgian educational methods, and here again one of the most prominent points is the teaching of geography, which is most completely systematised and thoroughly scientific; the minutely detailed maps of the War Department form the basis of much of this, dealing thoroughly with the physical and geological conditions of the country, which are gradually shown, one thing at a time, in a progressive series of maps. The technological and other school museums (notably that at Verviers) collected by the pupils, deserve special notice, as does the whole apparatus for handicraft teaching, such, for example, as the pasteboard models made by the pupils for the demonstration of problems in solid geometry, and of algebraical formulæ treated geometrically. The city of Antwerp furnishes a very interesting collective exhibit, further illustrating these points, and in this connection may also be mentioned the single exhibitors, D. Windels, whose zoological models of animals to scale are admirable, and J. B. Gochet, who shows a complete course of geography.

In the French Section the method and good gradation of all the school work and the way in which these points are illustrated in the exhibit are very remarkable. Here again we find great prominence given to the objective method of teaching in almost every subject; the results of the handicraft teaching of children from ten to thirteen in the Département du Nord are almost incredibly good, while the method of it in the Prevot Orphanage is excellent. The excellent choice of books for school libraries, the system of instruction in rhetoric and in the duties of citizenship, the results of the École Normale de Travail Manuel, and the programme of instruction for 1882, are particularly noticeable.

Of the English system, as illustrated by the Societies and the School Boards, the exigencies of space allow us to say but little. The publications of several of those enumerated above are well known, as are also their school appliances. For the methods and results of school work, the exhibits of the School Boards must be consulted. Here we are at once struck with the comparative absence of the apparatus for, and the results of, that objective system of teaching which stands out so prominently in the Continental systems. A praiseworthy exception to this, however, is to be found in the room devoted to the Birmingham School Board, where Mr. Jerome Harrison exhibits the apparatus and results of the itinerant system of teaching science to every child above Standard IV. in the Board schools of that town. The systematic arrangement of every subject of instruction, and especially of the needle-work, is particularly notice-

able here. More space is occupied by the London School Board, whose lending libraries for schools and reference libraries for pupil teachers are well selected. The geographical teaching cannot, of course, be compared with that on the Continent, though some of the district maps are good. Fair provision is made for teaching science to pupil teachers, but there is a lamentable deficiency in the apparatus for this and for the whole system of object-lessons, when the needs of the scholars themselves are considered. The School Boards of Edinburgh and Glasgow show some excellent models, photographs, and plans of school buildings of the newest type, and some remarkable specimens of drawing. The Wesleyan Education Committee show some excellent results of the scientific and handicraft training of boys, and some very simple yet remarkably effective appliances for elementary geographical instruction.

Although these collective displays by public bodies are the most interesting feature of this portion of the Exhibition, there is much that will repay examination in the various objects shown by many single exhibitors of the great variety of school desks and furniture; some of the desks of G. M. Hammer, G. E. Hawes, and H. Simon and Co., deserve more than a passing notice, as do also the revolving partitions of Hodkinson and Clarke. Among maps and charts the collection of Mr. E. Stanford stands out prominently, and is specially noticeable for the five series of physical and orographical maps, some of which in frames are on continuous sheets and rollers. Mr. Bacon's maps are singularly clear and good for school use, and his picture-lessons in geography are a step in the right direction. The apparatus for teaching music, exhibited by J. Curwen and Sons, is perhaps not approached by any similar exhibit. The science charts and diagrams produced by M. Emile Deyrolle are of an extremely high degree of excellence, and deserve to be made widely known. The educational publications of such firms as Messrs. Cassell and Co., Messrs. Gill and Sons, the Messrs. Johnston, Messrs. Griffith and Farran, Messrs. Bemrose and Sons, and Messrs. William Collins, Sons, and Co., who are all well represented, are too well known to need more than a reference.

In a second article we hope to deal in a similar way with the exhibits of apparatus and results of scientific and technical teaching carried to a higher degree than in mere primary schools, and also, briefly and by way of introduction, with that range of subjects which may be shortly described as comprising the technical education of children and girls. It may perhaps be permitted to the writer to say, as the result of a very close examination (extending over more than a week continuously) of the exhibits relating to primary education in various countries, that one important lesson to be learnt from the comparison of Continental methods with our own is the great advantage afforded by the objective system of teaching, and by the adoption of that systematic order and method in all subjects of instruction, literary or otherwise, to which the name scientific, in the highest and best sense of the term, is applicable.

WM. LANT CARPENTER

WORK-MEASURING MACHINES[1]

UNDER this title a little *brochure* has recently appeared from the pen of the Rev. F. J. Smith, B.A., of Taunton, in which work-measuring dynamometers, or *ergometers*, as the author terms them, of various forms are described. Amongst these machines there are many devised by the author himself, and some of these are of considerable interest and much originality. The transmission ergometers of the type originally invented by General Morin deserve notice in particular. The following is the general principle involved in transmission ergometers:—

Let it be supposed that a belt passes over from the driving wheel of a prime-mover such as a steam-engine to the pulley of a dynamo which is being driven. One half of the belt is subjected to a strong pull, the other is relatively slack. Then if we could introduce spring balances into the two parts of the belt, and if we could read the difference of the tensions T and T′, and if we multiplied this T − T′, expressed in pounds, by the velocity of the belt in feet per second, we should then have the "foot-pounds per second" spent in driving the dynamo. From this we can calculate the horse-power by dividing it by 550, since 550 foot-pounds per second is one horse-power. This we may write algebraically:—

$$\text{H.P.} = \frac{(T - T')}{550} v;$$

where v denotes the velocity of the belt in feet per second.

Now since such an arrangement as this cannot be easily carried out, the usual method is to place between the engine and the dynamo some instrument capable of showing the tension of the belt in pounds, and the velocity of the belt, and in certain cases these instruments can even give a continuous record of the work done. The ergometer devised by Mr. Smith is an admirable instance of such a combination, and it undoubtedly possesses points of superiority over all transmission dynamometers hitherto invented. A view of the machine (see figure) shows how the ergometer is arranged. The central shaft, of Whitworth steel, which is tubular at each end and link-shaped between, carries two pulleys. One is keyed to the shaft and carries two bevel-wheels, these engage with another bevel-wheel which forms part of the second pulley, which is loose on the shaft.

To each of the two bevel-wheels, as shown in the diagram, there is fitted a cylindrical drum, on these either gut or steel tape is coiled over three-fourths of their faces, and the gut or tape is attached to a cross-head. The latter is in turn attached to a cylindrical steel spring placed within the link, and from the cross-head a rod of steel, passing through one end of the link, actuates the pointer of a dial, whereby the pull on the spring attached to the end of the link is shown. This instrument resembles therefore the earlier dynamometer of Morin in having two pulleys; the angular advance of one of them being regulated by a spring. But in Morin's form the spring was simply an extended piece of steel. In the more recent modification by Profs. Ayrton and Perry, coiled steel springs are also used; but in that instrument the springs are liable to fly out by centrifugal force, and the arrangement for observing the angular advance is an optical one, requiring an observation of a silvered bead by a reading-telescope. In Mr. Smith's ergometer there is no such tendency of the spring to fly, and the tension is read direct on a dial. The speed indicator is shown just below. If a continuous record of work is required, the steel rod is either attached to a recording drum or to an integrating apparatus.

The instrument having been placed between a prime mover and a machine to be tested, the belt from the prime-mover drives the loose pulley, and another belt from the fixed pulley drives the machine to be tested. The tension on the driving side of the belt causes the spring to be extended by means of the bevel-wheels, and difference of the tensions is indicated by the pointer of the dial. The instrument is calibrated by hanging known weights from strong thin cords or catgut strings passing round the pulleys, and marking the dial in accordance with the weights.

The springs used by Mr. Smith are made by Messrs. Salter and Co., they are of four sizes, capable of being extended 2 inches by 50, 100, 150, and 200 lbs. respectively. They have been put to severe tests, but have come

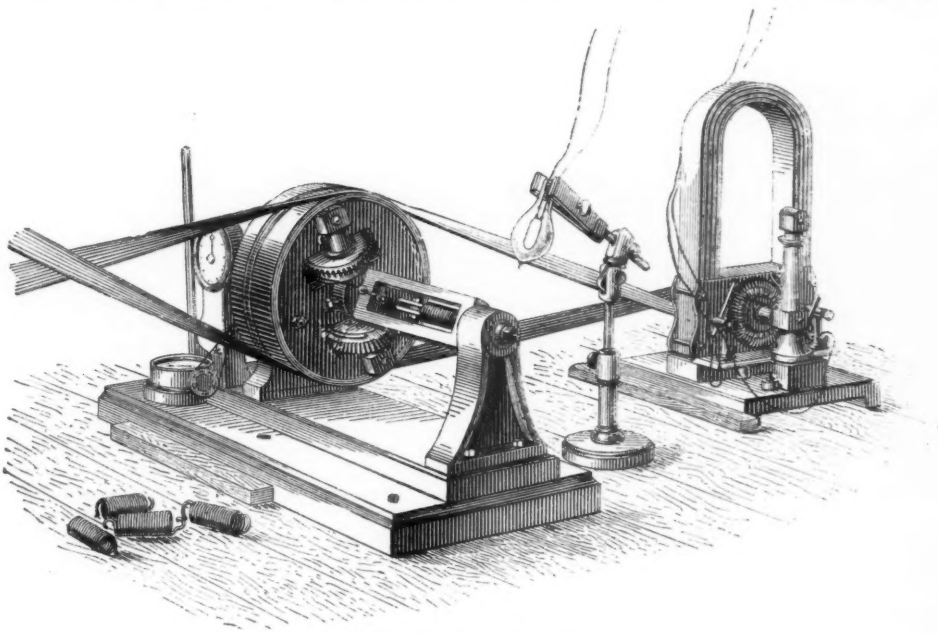
[1] "Work-Measuring Machines." By Frederick J. Smith, B.A. 32 pp. 12mo. (London: E. and F. N. Spon, 1884.)

out of them quite unaltered. However, so as to leave no doubt as to the accuracy of the readings of the ergometer, the instrument is finally calibrated by another method, which is new; it is as follows:—

Let a prime-mover (a water-wheel appears to be the most steady) drive the transmission ergometer, and let the ergometer drive a pulley on a shaft embraced by a suitable friction ergometer, such as a Prony brake or an Appold's brake, and let the work done against friction be calculated. This should agree with the results of the transmission machine. If it does, we may conclude that it has been correctly calibrated. The advantage of this method is that the transmission machine is tested while running in its usual condition. When testing a dynamo care should be taken that the speed indicator be well attached to the shaft the velocity of which it is measuring. A piece of coiled spring, such as is used in a dentist's lathe, answers well to connect it to the machine.

The leading feature of this instrument is the position of the spring in it. The axis of the spring and of the shaft coincide; the result of this is that it is hardly at all affected by centrifugal force. When springs of slight pull are used and the ergometer is driven at a great velocity, the deformation is considerable, and would introduce considerable error into the result.

The deformation of the spring has been fully appre-



Smith's Transmission Ergometer.

ciated by Schuckert, and therefore he has placed the spiral springs of his ergometer in cylindrical cases.

When the spring is placed with its axis coincidental with that of the machine, no such error can be introduced, and the friction of a spring against a case is avoided.

When a continuous record of work is required, a cylinder, not shown in the figure, is placed at the dial end of the instrument, and is driven at a speed proportional to the speed of driving. It carries a band of paper which receives a continuous trace from three self-feeding ink-pens: one pen is attached to the lever which is moved by the extension of the spring, and it writes ordinates directly proportional to the amount of extension of the spring at any instant; the second pen, attached to the lever of an electro-magnet magnetised by a current controlled by a seconds pendulum, describes a V-shaped mark at each second; the third pen traces a datum line to which the ordinates are perpendicular. The area traced out is of course the product of the two variables, and is proportional to the total work transmitted. The recording drum may be made to revolve at any convenient ratio to the revolutions of the belt wheels. We are indebted to Mr. Smith for the loan of the figure which illustrates this notice.

NOTES

We are authorised to state that there is no truth in the rumour that Mr. Oscar Dickson intends to equip an Antarctic Expedition under the command of Baron Nordenskjöld.

The Rev. Dr. Salmon, Regius Professor of Divinity in Trinity College, Dublin, has been selected by the Institute of France to fill its vacant foreign membership.

According to the constant practice of the French Academy of Sciences, the seat occupied by M. Jamin in the Section of Physics is considered as vacant, and a new election will take place.

A meeting was recently held in the Hall of the Institution of Civil Engineers, Great George Street, Westminster, to consider what steps should be taken to raise an Engineers' Memorial to the late Sir William Siemens. Sir Joseph Bazalgette, as President of the Institution, was asked to preside. The Chairman pointed out that a general desire had been expressed among engineers that some memorial should be raised as a recognition of the great merits and important services rendered to engineering by Sir William Siemens. It has been ascertained that it would be agreeable to the authorities of Westminster Abbey that a window should be placed in that building to the memory of the deceased. Possibly the cost of such a window might amount to

between 700*l.* and 800*l.* The meeting agreed "that it would be very desirable to commemorate the distinguished character and attainments of the late Sir William Siemens by erecting to his memory a window in Westminster Abbey." It was determined to limit the subscription in the first instance to one guinea. A committee was appointed to carry out the project.

THE ceremony of laying the foundation-stone of the building which is to be erected, under the name of Alexandra House, at the charge of Mr. Francis Cook, as a home for 100 of the female students attending classes at the Royal College of Music, the South Kensington Museum, and other art and science schools in the neighbourhood, was performed on Monday afternoon by the Princess of Wales in the presence of a large assemblage of gentlemen and ladies. Mr. Cook deserves all credit for his enlightened liberality, and we have no doubt the home which he has founded will be a valuable aid both to the South Kensington classes and the College of Music. At the same time we may remind our readers that a similar institution has been successfully at work for a considerable time in Byng Place for female students attending University College and other institutions for the higher education of women.

WE hope to be able in an early number to consider at length the report of the City Companies Commission. Meantime, among other suggestions of the Commission, we may note their recommendation to appoint by Act of Parliament a Commission to undertake (1) the application of a portion of the corporate incomes of the Companies respectively to objects of acknowledged public utility; (2) the better application of the trust incomes of the Companies; (3) should it prove practicable, the reorganisation of the Constitution of the Companies. The Commission moreover recommend that by the terms of such Act "objects of acknowledged public utility" be defined as scholastic and scientific objects, *i.e.* elementary education, secondary education, classical education, scientific research.

THE International Forestry Exhibition was opened on Tuesday afternoon at Edinburgh by the Marquess of Lothian, in the presence of a large company. Many foreign Governments were represented, and the Lord Provost and magistrates of Edinburgh attended in their official capacity. The Marquess of Lothian, in opening the Exhibition, said that a special object was the better forestry education of the country. The United Kingdom had more property in the world than any other nation; but in this particular it was behind other nations. We were the only country that had not a school of forestry, and we had to send our young men abroad to gain the necessary knowledge. That, surely, was not right, and he hoped that out of that Exhibition there would come a school for forestry which might possibly be located in Edinburgh. They had every possible advantage there; they had the Botanic Gardens, the Arboretum, the University, and the Highland Society. All these bodies took an interest in the matter, and it only required that opportunity should be given for the practical part of the work. It was not too much to hope that before long, if the money were got, they might see a school of forestry in Scotland. He appealed to the public to make the enterprise a success, and, amid hearty cheers, declared the Exhibition open.

THE Anniversary Meeting of the Sanitary Institute of Great Britain will be held in the Theatre of the Royal Institution, Albemarle Street, on Thursday, July 10, at 3 p.m. The chair will be taken by the Right Hon. Earl Fortescue, and an address will be delivered by H. C. Bartlett, Ph.D., F.C.S., entitled "Some of the Present Aspects of Practical Sanitation," and the Medals and Certificates awarded to the successful exhibitors at the Exhibition at Glasgow, in 1883, will be presented.

THE Society of Chemical Industry will hold its annual meeting at Newcastle-on-Tyne on July 9 and following days. The meeting at Newcastle is looked forward to with great interest by the members of the Society throughout the country, for Tyneside is associated more closely than any other district with the birth and development of the chief of our great chemical manufacturing industries, and the committee of the Newcastle section, under the chairmanship of Mr. J. C. Stevenson, M.P., are doing their utmost to render the visit of the members to Newcastle in every way a memorable one.

MR. SIDNEY LUPTON, Assistant Master at Harrow School, has recently compiled and published some numerical tables and constants in elementary science which we can fairly recommend to our readers. It is a little book of about 100 pages, which of course possesses no claim to originality, the whole skill of the compiler being shown in the selection of materials which he has made. The book deals with numbers and measures, heat, light, sound, electricity, chemistry, and physiography; the latter division being wide enough to include tables of logarithms.

WE have received from the Bureau des Longitudes their "Annuaire" for the present year, which seems thicker and more complete than any of its predecessors, well worth the money it costs (1*s.* 3*d.*) even to the English reader, on account of the very valuable tables which it contains touching astronomical and geographical subjects. We notice in the present edition a very complete table of the different comets, which alone would make it a necessity in any astronomical establishment. The semi-popular article published in the "Annuaire" for this year is entitled "Sur les Grands Fleaux de la Nature"; it is by M. Faye, and is well worth reading.

M. MONTIGNY has recently published a pamphlet on the influence of the atmosphere in the apparition of colours seen in the scintillation of stars. In it he draws attention to the possibility of there being some connection between these colours and the coming weather. He has previously noticed that there is a great predominance of blue in the scintillating colour when rain is approaching, and he is now so convinced of the accuracy of this forecast that it is included among others in the *Bulletin Météorologique* published by the Observatory of Brussels. He gives the following forecast for the coming years:—"We may hope that we are happily quit of the period of wet years which commenced in 1876, and that we have already entered a series of fine years, or rather of more regular years as far as rain is concerned." *Nous verrons ce que nous verrons.*

OUR botanical readers may be interested to know that Herr F. Soácha of the Bürghschule, Deutschbrod, Bohemia, is preparing for publication a Flora of Austria-Hungary, which will contain specimens of the plants described. Those desiring to know the terms of subscription should communicate with Herr Soácha.

THE following are some of the special questions which have been arranged for discussion at the next Social Science Congress, which is to be held at Birmingham on September 17–24:—How far are the requirements of the country for well-trained teachers in elementary schools met by the pupil-teacher system and the existing training colleges? In testing the efficiency of schools should processes or "results" be chiefly regarded? Health—1. What is the best method of dealing with (*a*) town sewage, (*b*) the products of house and street scavenging, and (*c*) the products of combustion? 2. What are the best means, legislative or other, of securing those improvements in the dwellings of the poor which are essential to the welfare of the community? 3. How far may the average death-rate of a population be considered

an efficient test of its sanitary condition; and by what means can the high death-rate of children be reduced?

THE Pavlovsk Observatory has been, since 1882, in possession of two subterranean lines, each one kilometre long, and situated, one of them in the direction of the magnetic meridian, and the other perpendicular to it; and Dr. Wild communicates to the St. Petersburg Academy of Sciences (*Bulletin*, vol. xxix. No. 2) the following interesting results of his observations on terrestrial currents (the method of observation has already been described in the *Memoirs* of the Academy, vol. xxxi.):—The terrestrial current altogether does not manifest itself as a current which would flow for a time in one direction and then would slowly change it, but in the shape of more or less strong alternate currents, which rapidly change their direction. The east and west force is generally stronger than that of north and south. The observations on the regulation days do not show any diurnal periodicity, neither in the force of the current nor in the number of oscillations; but the average of the twenty-four regulation days of the year (September 1882 to September 1883) disclose such a periodicity, however feeble, namely, a maximum between 4 and 5 a.m. and a minimum at 8 p.m. for the meridional line, as also a maximum at 8 a.m. and a minimum at 1 p.m. for the other line. As soon as the force of the terrestrial current is on the increase, the magnetical instruments display perturbations which usually increase with the force of the terrestrial currents, without being, however, proportionate to them. If, according to Sir G. B. Airy, the north and south current be compared with the variations of declination, and the other current with horizontal intensity, both perturbations are often very equal, but those of the currents precede those of the terrestrial magnetism by at least five minutes. This retardation may explain the want of proportion between the variations of the current and those of the terrestrial magnetism, which proportion is the more wanting as the variations of the current are frequent and alternate. From these alternations Dr. Wild concludes that "terrestrial currents are always the primary cause of magnetic perturbations, but not of periodical variations of the magnetic elements."

SOME forty years ago Dr. Joule raised the question whether a body that is magnetised undergoes any change in its temperature; but the question has not yet received a definite solution, the rise of temperature which accompanies magnetisation being ascribed by some to induction currents, and not directly to magnetism. While recognising the influence of the former, Mr. Borgman has tried to show that there is also a change of temperature due to magnetisation and demagnetisation, and that the amount of heat thus disengaged is proportionate to the squares of the temporary magnetism. M. Bachmetieff, having made, at the University of Zurich, an extensive series of experiments, the first part of which is now published in the *Journal of the Russian Chemical Society* (vol. xvi. fasc. 3), arrives at the conclusion that magnetism, *by itself*, produces variations of temperature in magnetised bodies, and that this "magnetic heat" is equal to the product of the magnetic moment by the magnetising force multiplied by a constant; it increases also, within a certain limit, with the frequency of the interruptions of the magnetising current, and increases still more when the direction of the current is alternately changed. Its amount is not equal throughout the length of an iron cylinder, reaching its maximum about its middle and decreasing towards its ends. Its cause must be searched for in purely mechanical forces, and it depends upon the speed of rotation of the molecular magnets.

ABOUT the middle of June the inhabitants of Moscow were puzzled to see immense masses of insects, taken at first for locusts, flying east in thick clouds over the city. It appears now that the insects were dragon-flies (*Libellula quadrimaculata* and *L. rufa*) belonging to the rapacious species which live on other insects.

COUNT UVAROFF continues his archæological explorations in the Government of Smolensk, and recently he has found very interesting remains of rude pots containing ashes and bones which are supposed to be burial remains of the Krivitchi, who had the custom, according to the Nestorian annals, of thus burying their dead.

DR. CHAVANNE, who is travelling on the Congo for the Brussels National Institute of Geography, has established a meteorological observatory at Boma. Mr. Stanley has transferred the site of his station of Vivi to a table-land some 1500 metres to the north; and a railway from the new station to the Congo is in course of construction. A new station, called Sette-Cana, has also been established at the mouth of the small River Sette. Numerous small wooden houses are being made in Belgium to be transported to the new Vivi. A sanatorium has been constructed at Boma.

A TELEGRAM from Krasnovodsk gives the true history of the Uzboi, the ancient bed of the Amu Daria. For 250 versts, from Sarykamish to Bola Ishem, there is no stream, this locality presenting a series of desiccated marshes and lakes. At Akkal there is no channel. This part of the Uzboi, which evidently formed an estuary of the Caspian and partially fed the Sarykamish lake, has been silted up from the sea. The project for uniting the Amu Daria with the Caspian requires several hundred versts of canals.

M. JAUBERT has organised in the Great Tower of the Trocadéro Palace a repetition of the experiments tried by Pascal in the Tour Saint Jacques, on the diminution of barometric pressure with increase of altitude. He is also arranging a Foucault pendulum which will oscillate in the same condition as in the Pantheon, with a contrivance for making its vibration perpetual.

THE additions to the Zoological Society's Gardens during the past week include an Indian Wild Dog (*Canis primævus*) from India, presented by Mr. T. A. Bulkeley; a Brush-tailed Kangaroo (*Petrogale penicillata* ♂) from New South Wales, presented by Mr. J. Abrahams; a White-collared Mangabey (*Cercocebus collaris* ♂) from West Africa, presented by Mrs. Du Heaume; a Black-eared Marmoset (*Hapale penicillata* ♀) from South-East Brazil, presented by Mrs. C. Spencer Stanhope; a Guianan Tree Porcupine (*Sphingurus insidiosus*), a Rough Fox (*Canis rudis*) from British Guiana, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Laughing Kingfisher (*Dacelo giganteus*) from Australia, presented by Mrs. W. Moir; two Chaplain Crows (*Corvus capellanus*) from Persia, presented by Mr. B. T. Ffinch; a European Pond Tortoise (*Emys europæa*), two Spotted Salamanders (*Salamandra maculosa*), European, presented by Mr. J. Satcherd; two Algerian Tropidosaures (*Tropidosaura algira*), three Rapid Spine-foot Lizards (*Acanthodactylus vulgaris*) from North Africa, presented by Mr. W. C. Tait, C.M.Z.S.; an Adorned Ceratophyrs (*Ceratophyrs ornata*) from South America, presented by Capt. Hairby; an Orange-winged Amazon (*Chrysotis amazonica*) from South America, a St. Thomas's Conure (*Conurus xantholæmus*) from St. Thomas, W.I., a Yellow Conure (*Conurus solstitialis*) from Guiana, two Passerine Parrots (*Psittacula passerina*) from British Guiana, deposited; a Bengal Vulture (*Gyps bengalensis*) from India, two Coscoroba Swans (*Cygnus coscoroba*) from Chili, three Turquoisine Parrakeets (*Euphema pulchella*) from New South Wales, purchased; two Black Guillemots (*Uria grylle*) from Ireland, received in exchange; a Hog Deer (*Cervus porcinus* ♀), four Himalayan Monauls (*Lophophorus impeyanus*), five Chilian Pintails (*Dafila spinicauda*), five Summer Ducks (*Œx sponsa*), bred in the Gardens.

THE COMPOSITION OF CHLOROPHYLL

AMONG recent papers on chlorophyll those of Hansen, assistant to Prof. Sachs, are worthy of notice.[1]

Dr. Hansen has applied the saponification method, found so useful by Prof. Kühne [2] in his researches on the chromophanes, to the study of chlorophyll, and has been led to some very important conclusions. It may be remembered that Fremy tried to show that the green chlorophyll colouring matter consists of a blue and a yellow constituent. He mixed an ethereal chlorophyll solution with hydrochloric acid, when two layers formed—a lower blue layer and an upper yellow ethereal layer. The blue colouring matter was named by Fremy *phyllocyanin* and the yellow *phyll-xanthin*.

Hansen shows that this is not due to a splitting up of the chlorophyll green into a blue and a yellow component, but only an incomplete separation of the chlorophyll green from the chlorophyll yellow, the former becoming changed to blue by the hydrochloric acid, and he further shows that an ethereal solution of pure chlorophyll green treated with hydrochloric acid does *not* furnish any yellow constituent, the ethereal layer remaining colourless. Fremy himself, however, abandoned the view that chlorophyll consists of two colouring matters.

The views of Kraus are so well known that it is hardly necessary to recapitulate them here, but I may be permitted to recall to mind that he supposed he had decomposed chlorophyll green into a blue green and a yellow component. He mixed an ordinary alcohol chlorophyll solution with benzol, and obtained two layers, an underlying yellow alcoholic layer and an upper blue-green layer. The blue-green Kraus named *cyanophyll*, the yellow *xanthophyll*.[3] Hansen shows, however, that Kraus is wrong in supposing that a *decomposition* of the green colouring matter into a blue-green and a yellow has taken place, as it is only an *incomplete separation* of the chlorophyll green from the chlorophyll yellow. Kraus's *cyanophyll* therefore is nothing more than an ordinary chlorophyll solution out of which a part of the yellow colouring matter has been removed. Both Fremy and Kraus were correct in assuming that a yellow and a green constituent were present, but incorrect in supposing they existed *in combination;* the correct view now is that *they exist side by side.* In other words, chlorophyll is merely a *mixture* of these colouring matters.[4] [I think it necessary here to give Conrad's view, viz. that Kraus had effected a decomposition of the chlorophyll by the use of water, as Kraus used weak alcohol. Conrad showed that by using strong alcohol no yellow pigment could be got into solution by means of benzol. Cf. Sachs' "Botany," 2nd English ed. p. 760.] In the preparation of pure chlorophyll Hansen used young plants of wheat at the time of their growth when the fourth leaf is formed. Then the plant contains only protoplasm, chlorophyll, and cellulose. The spectra of the solutions were observed as in the experiments of Kühne,[5] on the pigments of vertebrate eyes, and of Krukenberg [6] on those of various animals, by means of sunlight thrown into the slit by a heliostat, a large chemical spectroscope having been used.

The leaves of the plants are first boiled to remove extractives, the water poured off, and the material washed with water until the wash water is quite clear. It is then quickly dried at a low temperature, and afterwards extracted with alcohol. Hansen states that the boiling does not alter the chlorophyll, since the plant residue, after boiling, gives the same bands as the living leaf. For the alcoholic extraction 96 per cent. alcohol was used, and it was carried on in a dark room to avoid decomposition of the chlorophyll by light. A second extraction was also carried out, and the alcohol left in contact with the residue until the former assumed a dark green colour.

The united alcoholic solutions were then concentrated and *saponified*. Hansen had previously found that he could separate out, in the case of the colouring matter of blossoms, by means of saponification, the yellow colouring matters from the fats in combination with them, as Kühne had previously done in the case of the *chromophanes* and other pigments, and not only did he get the pigments fat-free, but also in a crystalline state.

[1] "Der Chlorophyllfarbstoff," von Dr. Adolph Hansen, *Arbeiten des botan. Instituts zu Würzburg*, Bd. iii. Heft 1; and *Sitzungsberichte der physikal.-medicin. Gesellschaft.* Wurzburg, 1883. Also, *Die Farbstoffe der Blüthen und Früchte. Verhandlungen der physikalisch-medicinischen Gesellschaft zu Wurzburg*, N.F., Band xviii. No. 7, 1884.

[2] Kühne, *Untersuch. a. d. physiologischen Institute der Univ. Heidelberg*, Band i. Heft 4, 1878, and Band iv. Heft 3, 1882.

[3] "Zur Kenntniss der Chlorophyllfarbstoffe," &c., Stuttgart, 1872.

[4] *Ibid.* [5] *Loc. cit.*

[6] Krukenberg, "Vergleichend physiol. Studien," 1880-82.

The saponifying was carried out as follows:—The leaf-extract (alcoholic), after concentration, was treated with caustic soda solution in not too great amount, but the amount to be added has to be determined by the quantity of chlorophyll present. As a general rule Hansen used 40–50 c.c. (of a 1NaHO to $5H_2O$ solution) to 2½ c.c. chlorophyll solution obtained by concentration of 16–20 c.c. alcohol extract. When the alcoholic solution boils, the caustic soda is added drop by drop, the liquid being stirred. After the alcohol is driven off, water is poured in, and the heating continued. After the evaporation of a great part of the water, alcohol is added once more, and the saponification is ended. When the alcohol has evaporated, the soap lees is diluted with water and an excess of chloride of sodium added to separate the soap, which precipitates in a granular form. It is then shaken in a separating funnel with petroleum ether, which assumes a dark yellow colour, since it removes only the yellow constituent; this extraction is repeated as long as the petroleum ether is coloured. On evaporation of the latter, the *yellow* constituent is left.[1]

The soap is now treated with ether, which removes various impurities, and a little colouring matter, and then with ether containing alcohol, which removes the *green* constituent from the soap.

Hansen asserts, and gives his reasons for the assertion, that no change takes place in the pigments by the above treatment.

The *yellow* constituent crystallises in dark yellow needles out of the petroleum ether, and gives all the reactions of a lipochrome, both as regards spectrum and chemical characters.

The *green* constituent can be obtained out of the ether-alcohol solution after occasional filtering and evaporation of the ether, and any yellow colouring matter adhering to it can be removed with petroleum ether. For the usual reactions this pigment answers very well, but for further study it has to be purified from water, &c., which is done by further treatment with ether-alcohol solution. Finally the pigment crystallises out in spherical crystals, which show a beautifully-marked cross with crossed Nicols. Even a drop of the solution allowed to evaporate on a microscopic slide allows the crystals to be seen, thousands of small "sphærocrystals" appearing on the evaporation of the ether. Hansen shows that the idea that plants contain but a small quantity of chlorophyll is erroneous, as he has obtained out of 450 grams dried wheat leaves as much as three to four grams solid colouring matter.

Chlorophyll green is opaque in the solid state, and appears of a black-green colour, and in that state possesses no fluorescence, but in solution possesses the usual red fluorescence. Its various chemical characters are given at length in the original paper, and it is shown that some of the changes with acids described by authors are not due to their action on pure chlorophyll green, but on other unknown bodies. It is free from sulphur and from iron. The elementary analyses agree very closely, and calculated for the ash-free substance are the following:—

	I.		II.
C.	67·26 per cent.	...	67·94 per cent.
H.	10·63 ,,	...	10·36 ,,
O.	16·97 ,,	...	16·12 ,,
N.	5·12 ,,	...	5·55 ,,
	99·98		99·97

The amount of carbon is 1 per cent. too low in both cases.

Chlorophyll yellow occurs in small quantity as compared with chlorophyll green, in the proportion of about 1 to 100. Its solutions show no fluorescence, and statements to the contrary have been based upon deductions drawn from imperfect methods of separation. It possesses the reactions of Krukenberg's *lipochromes*,[2] in the solid state, namely: a blue coloration with sulphuric acid, the same with nitric acid, and a green-blue with a mixture of iodine in potassium iodide. It shows three bands in the blue half of the spectrum, but no absorption of red, and agrees in spectrum with the yellow colouring matter of etiolated leaves (*etiolin*), which is incorrectly represented by some as possessing bands in the red part of the spectrum. Chlorophyll green possesses four bands in the red half of the spectrum; they agree with the four bands of the ordinary chlorophyll solutions.

With regard to Tschirsch's "pure chlorophyll," which, it may be remembered, was described in the *Journal of the Chemical Society*, February 1884, with the remark that the writer "reserved to"

[1] Compare Kühne, *loc. cit.*, Band iv. Heft 3, 1882.

[2] Krukenberg, *loc. cit.*, "Zur Kenntniss der Verbreitung der Lipochrome im Thierreiche," Zweite Reihe, 3te Abth. 1882.

himself "the right of examining it further," Hansen observes that "it possesses all the reactions of the usual chlorophyll sauce."[1]

In a second paper[2] Hansen figures the spectra of chlorophyll green and chlorophyll yellow. His researches will, no doubt, be found useful by students of vegetable chromatology.

C. A. MACMUNN

RECENT MORPHOLOGICAL SPECULATIONS[3]

II.—*The Origin of Vertebrates*

FIFTEEN or sixteen years ago Kowalevsky's researches on the development of Amphioxus and of Ascidians seemed to be solving the question of the origin of Vertebrates. The discovery of the larval notochord in Ascidians, and the recognition of the homology of their pharyngeal clefts with the gill-slits of Vertebrates, made it necessary to acknowledge the close relationship of the two, as had been already foreshadowed by Herbert Spencer; while the yet undisputed affinity of Ascidians to Mollusks brought Vertebrates and Invertebrates together in an unbroken line. But as new knowledge brought Ascidians closer to Vertebrates, it undermined their claims to molluscan affinities; and as the doctrine of degeneration grew up, in the hands of Dohrn and Lankester, it taught that Ascidians, and Amphioxus too for that matter, were not really *ancestors* of the higher Vertebrata, but only degenerate descendants of such ancestors, poor cousins, as it were, of the higher Vertebrates. The lines by which Vertebrates had sprung from Invertebrates, the common ancestor of Ascidians, Amphioxus, and the higher Vertebrates, had still to be sought for.

Two leading theories have been formulated, and are still under discussion. The first, identified with the names of Semper and Dohrn, maintains that the nearest allies of the Vertebrates must be looked for among the Chætopod worms, the dorsal surface and spinal cord of the former corresponding morphologically with the ventral surface of the latter, and its gangliated nerve-cord. On the second view, with which we may associate the names of Balfour and Hubrecht, we must take the ancestor of the Vertebrates to have been some segmented worm, descended from the same unsegmented types as the Chætopods, but in which the two nerve-cords, at first lateral like those of Nemertines, had coalesced dorsally instead of ventrally, to form a median nervous system.

Our discussion of the first of these theories may be made clearer if we use the words "neural" and "hæmal" instead of "dorsal" and "ventral," for the gist of the theory is that in the two groups *neural* and *hæmal* surfaces remain constant, but what is dorsal in the one is ventral in the other.

In the Chætopods, say the advocates of this theory, we have a group of regularly segmented animals, not so far specialised but that we might well conceive ancestors like them to have developed into Vertebrates; they point to the relations of the nervous, vascular, and alimentary systems, and to the development of the mesoblast, as being closely parallel in the two groups; and they try to find traces or representatives in Chætopods of such typically Vertebrate possessions as notochord, gill-clefts, and swimming-bladder.

At the very outset a difficulty arises which is perhaps the greatest the theory encounters. The mouth of Chætopods is neurally placed, and surrounded by a nerve-ring; in Vertebrates it is hæmal, and it does not pierce any part of the nervous axis. Dohrn has attempted to overcome this objection. The present mouth of Vertebrates, he says, is not identical with the Invertebrate mouth; it is a distinct and secondary structure; it arises late in development, whereas in other classes the "stomodæum" or primitive oral invagination appears very early. Moreover, in the majority of Vertebrates the mouth does not persist in the position it first appears in; it arises some way off from the anterior end of the body, and in Elasmobranchs, some Ganoids, and Myxinoids it remains there, but in all other Vertebrates it becomes terminal. If we assume, then, that the mouth in existing Vertebrates is secondary, there must have been a time when it did not exist, and when its functions were performed by another or primary mouth. It has been suggested that in the ***hypophysis cerebri*** or "pituitary body" we have, possibly, a remnant of this primary mouth. The hypophysis cerebri appears first as an ectodermic involution, usually arising from the stomodæum; but in the lamprey, Götte, Scott, and Dohrn have shown that it arises from the ectoderm which lies anterior to the mouth. It is here, in fact, a little pit of ectoderm, placed between those other two ectodermic pits, which are to become the nose and the mouth.

If this involution ever pierced the brain and opened upon the neural surface, the fore-brain would then be evidently homologous with the supra-œsophageal ganglion of Invertebrates, or ganglion of the præ-oral lobe. A great deal may be said for thus regarding the fore-brain as distinct from the remaining nervous system; it resembles the supra-œsophageal ganglion of the Invertebrata in its close connection with the optic and olfactory organs, and in supplying only organs of sense. There is evidence to show that the third nerve belongs to the cranio-spinal series of segmental nerves, and that the olfactory and optic nerves have a different nature. If this be so, the mid-brain, giving origin to the third nerve, would appear not to have part in the ganglion of the præ-oral lobe. The termination of the notochord directly behind the fore-brain is an additional argument in favour of the morphological distinctness of the latter structure.

Thus if we follow back the genealogical record of the Vertebrates, we find that at one period their ancestors had a mouth upon the neural surface; later, two openings into the alimentary canal appear, one on the neural and one on the hæmal surface; still later the latter gains the ascendancy, and alone remains to the present time. This secondary mouth must have arisen from some pre-existing structure; it could not have originated as a simple depression of the outer skin which deepened and ultimately fused with the alimentary canal; and the only pre-existing organs which could furnish such a passage from the exterior into the alimentary tract are the gill-slits. We must conceive this Vertebrate ancestor as an animal with an intestine which opened anteriorly by a median mouth on its neural surface, and laterally by a series of segmentally situated gill-slits. The mouth took in water, which flowed out over the gill-arches just as it does still in the lower Vertebrates. If from any reason, such as the animal lying like the modern Annelids on its neural surface, it obtained a purer supply of water by taking it in through some of the gill-slits, it is conceivable that a pair of these slits assumed that office, and that by the exercise of this power the gill-slits became gradually larger, and ultimately fused in the middle line. The suctorial power thus acquired to take in water for the purposes of respiration was also of use in obtaining food, and thus a median hæmal suctorial mouth arose, such as the Myxinoids now possess. There is much evidence to show that the ancestral Vertebrate possessed a suctorial mouth which subsequently became modified for biting, and was carried forward to the front of the head. Embryology supplies the following arguments in favour of regarding the mouth as formed from the coalescence of a pair of gill-slits. It lies close against the gill-slits, it is separated from them by a gill-arch, it arises about the same time in the embryo, it opens into the alimentary canal; finally, in some Teleosteans, *Belone*, *Hippocampus*, and *Gobius*, the mouth first appears as two lateral openings, which afterwards fuse in the middle line.

Admitting that the mouth is formed of two gill-slits, we have to see from what structures in an Annelid such gill-slits could be derived. In many Chætopods no part of the body is set apart to perform the function of respiration. Where there are no gills the blood is commonly aërated in the walls of the alimentary canal, water being taken in at either end, and when charged with the waste products of respiration, it is expelled through the same opening. In some cases, as in *Hesione*, the surface with which the water comes in contact is increased by a pair of lateral sacs or diverticula. It is obvious that with such a respiratory apparatus it would be advantageous if there was an exit for the respired water distinct from its entrance, so that the blood should always be in contact with pure water. Such an exit would be formed by fusion of the respiratory diverticula with the body-wall and subsequent rupture of the latter at the points of fusion. And the apertures in the tentacles of Actiniæ and the perforated liver-diverticula of Eolis are adduced as analogous instances of such perforation.

Another suggestion which has been made to account for the origin of gill-slits is that the inner ends of some of the segmental organs gained an entrance into the alimentary tract, and, changing their function, gave rise to gill-slits.

By these steps a Vertebrate has been reduced to an Annelid structure, but certain questions which have arisen in the development of this theory remain to be answered. One is whether the

[1] Tschirsch only obtained his chlorophyll in the form of "blackish-green drops."

[2] *Loc. cit.*

[3] Continued from p. 69.

mouth is formed from the most anterior pair of gill-slits. If the trabeculæ cranii are gill-arches, the mouth is not the first. Some authorities consider the nasal sacs as modified gill-slits; they are primitively double, and where we find them single, as in Amphioxus and Cyclostomes, it is due to secondary processes.

In his "Monograph on the Development of the Elasmobranch Fishes," Balfour has pointed out that the histological structure of the spinal cord in Vertebrates is exactly what would be found if, by mechanical folding, the two lateral halves of the nerve-cord of an Annelid became bent toward one another, whilst the external skin was pushed into the groove between them. If this folding were completed, so that the external epithelium formed a canal surrounded by nervous tissues, the white and gray matter would assume the same relative position that they possess in the spinal cord of Vertebrates. The nerves would then arise not laterally, but from the extreme ventral summit, and would thus correspond with the posterior roots of the Vertebrate spinal cord, which, as Balfour has shown, grow out from the extreme dorsal summit of the neural canal, a position comparable with the ventral summit of the Annelid nervous system. In Amphibia the primitive medullary plate (or modified area of dorsal epiblast which is to fold in and form the medullary groove), although elsewhere single, shows signs of being formed of two symmetrical halves, and in both embryo and adult the neural tube has a structure which points to its origin from the coalescence of two lateral cords.

The direction of the blood current, which flows from behind forwards on the hæmal, and from before backwards on the neural, surface, agrees in Chætopods and Vertebrates if the surfaces be reversed, and the hypothesis of reversal presents no great difficulties in the case of a cylindrical animal swimming in the sea.

In connection with this theory it is interesting to note that Eisig has instituted a comparison between the lateral sense-organs in the Capitellidæ (a family of Chætopods) and the lateral line of fishes, and he further compares the "siphon" of the same Chætopods with that obscure rod of tissue split off from the alimentary tract of fishes and Amphibia, the sub-notochordal rod.

The notochord is one of the most characteristic Vertebrate structures, and if the theory propounded above be true, we should expect to find very distinct rudiments of such a structure amongst the Chætopods, but although numerous organs have been interpreted as such, Balfour states that none of these interpretations will bear examination. Quite recently Nussbaum has found in the cockroach a longitudinal string of cells lying upon the nerve-chain, which in its development bears a striking resemblance to the notochord of Vertebrates, and Vejdovsky has described a similar structure in Oligochæta, developed, however, from the mesoderm, under the name of neurochord.

The supporters of the second theory, which we have connected with the names of Balfour and Hubrecht, claim that they have found an organ in one class of the Invertebrata which is comparable to the notochord of Vertebrata.

Balfour in the "Elasmobranch Fishes," whilst combating the Chætopod origin of Vertebrates, suggested that Vertebrates have descended from the same unsegmented stock as the Chætopods, but through some other line which has entirely disappeared. They have thus acquired similar segmental and other organs. In this line of ancestors he imagines that the primitive lateral nerve cords have tended to coalesce dorsally instead of ventrally. In his "Comparative Embryology" he repeats these views, and adds that their probability has been increased by the researches of Hubrecht, who has shown that in some Nemertines the nerve-cords approach each other very closely in the median dorsal line. Hubrecht has quite recently amplified these views by suggesting that "the proboscis of Nemertines, which arises as an invaginable structure, and which passes through a part of the cerebral ganglion, is homologous with that rudimentary organ which is found in the whole series of Vertebrates without exception—the hypophysis cerebri. The proboscidian sheath of the Nemertines is comparable in situation (and development?) with the notochord of Vertebrates."

The first of these two positions is supported by the facts of development. Although the details of the ontogenetic origin of the Nemertine proboscis are still wanting, the broad fact that it arises, like the hypophysis cerebri, as an invagination of the epiblast, has been established.

These organs further resemble each other in the shifting of their external opening, which is in some cases on the outer surface, in others on the dorsal wall of the alimentary canal just within the mouth.

In this comparison between the proboscis of Nemertines and the hypophysis cerebri, the connection of the latter with the brain and its relation to the anterior end of the notochord, must be especially borne in mind. The proboscis passes backward, between the anterior thickenings which form the brain, the two lateral halves of which are connected by a thick nerve commissure ventral to the proboscis, and by a thin strand dorsal to it. Thus the proboscis pierces a ring of nervous tissue, and the proboscis sheath reaches forward to the level of this nervous commissure. This region, then, would correspond to that part of the vertebrate brain to which the hypophysis cerebri is attached and close behind which the notochord terminates, and would thus separate off the fore-brain from the remaining nervous system. In connection with this it is a very significant fact that the superior lobes of the Nemertine brain give rise to the nerves which supply the sense organs, while the strong nerve which supplies the anterior region of the œsophagus originates in the inferior lobes. The one pair of these lobes may thus have been perpetuated as the fore-brain, and the other as the rest of the nervous system.

The sheath of the proboscis corresponds very accurately in its position to the notochord, but unfortunately the knowledge we possess of its development is not great. Barrois and Salensky have attributed a mesoblastic origin to it, the latter, however, noting a connection between the first origin of the œsophagus and proboscis. Hoffman has stated that part of the proboscis is split off the dorsal surface of the alimentary canal, whilst the muscular proboscis sheath is mesoblastic in origin. Hubrecht suggests that possibly the formation of the inner part of the proboscis sheath has been mistaken for the proboscis. If this suggestion prove true, then the proboscis sheath agrees both in position and origin with the notochord of Vertebrates.

The fully-developed notochord is a solid rod, whereas the proboscis sheath is a hollow tube. This, however, is no very serious objection to their homology; and recently Lieberkühn and Braun have shown that the notochord arises at first as a hollow tubiform structure, whilst in old specimens of *Cerebratulus* (a Nemertine) the posterior end of the proboscis sheath is nearly or quite filled up with continuous cellular tissue.

We have unfortunately too little knowledge at present to institute a comparison between the other organs of Nemertines and Vertebrates. Attention should, however, be called to the ciliated lateral pits upon the head. These arise from the most anterior part of the œsophagus in front of the mouth. They bud out from the walls of the œsophagus, and are in this stage directly comparable to similar diverticula which arise in the same region in the larva of *Balanoglossus*, and which there give rise to the first pair of branchial slits. These diverticula become finally cut off from the œsophagus, but enter into connection with epiblastic invaginations, and are thus placed in communication with the sea-water. In Schizonemertines their inner end is in connection with the brain; the latter contains hæmoglobin, and so they subserve respiration. In Hoplonemertines, however, although their development is similar, they apparently are modified for a sensory, possibly an olfactory, function. In connection with these structures, Hubrecht calls attention to some of the results of Hatschek's recent researches on the development of Amphioxus. In this animal there are two lateral hypoblastic diverticula growing out from the anterior part of the œsophagus in front of the mouth. These differ both in their nature and development from the archenteric diverticula, or from the branchial outgrowths. They are at first symmetrical, but have a different fate. They are both constricted off from the hypoblast: the left one communicates with the exterior by a ciliated opening which appears in the epiblast; the right one forms an epithelial lining to the præoral body region. The left one has been looked upon as a special sense organ of the larva.

Finally it is impossible to overlook the bearing of Balanoglossus on our subject, although we are not yet in possession of all the facts that Mr. Bateson's (*Q. J. M. S.* No. xciv. April 1884) recent researches seem to have elicited. The pharyngeal slits of Balanoglossus have long been recognised as wonderfully like the gill-slits of Vertebrates, and on the other hand as totally unlike any structures possessed by animals outside the Chordata. But Bateson's researches have already shown that the developmental features of the nervous system and of the mesoblast are not less suggestive of the same kinship. For the mesoblast is developed from an anterior archenteric pouch with two posterior horns (exactly comparable with that described in the last paragraph as existing in Amphioxus) and two pairs of posterior pouches instead of the larger number that Amphioxus possesses. And the fate

of the anterior pouch is almost identical in the two forms, for in Balanoglossus its left-hand division becomes lined by cilia and opens to the exterior, whereas its right-hand half degenerates into connective tissue. And as regards the nervous system (which in Balanoglossus contains no mesenteric canal as that of Amphioxus does) "it is only necessary to imagine the invagination of the dorsal nerve-cord to have been extended along the back (instead of being confined to the region of the collar) in order to reproduce the condition which is found in Amphioxus." But however much we may be struck by these relations of Balanoglossus, its own isolated position and the extreme difficulty of allying it to any other Invertebrate groups prevent it from throwing much light upon the Vertebrate pedigree. The claims of the two theories discussed above may be unaffected, however close the correspondence between Amphioxus and Balanoglossus may be shown to be; and as yet Balanoglossus seems to do little more than remind us of how remote a relative of the Vertebrates Amphioxus itself is. Amphioxus occupies such an outlying branch, so far from the main stem of the genealogical tree of Vertebrates, that the demonstration of its likeness to an isolated Invertebrate like Balanoglossus may, like its obvious relationship with the Tunicates, be of little use to us.

It is perhaps premature to judge between these two theories detailed above, or to accept either of them definitely as an indication of the origin of Vertebrates. But we must point out that the Chætopod theory lies under the great disadvantage of assuming as far distant ancestor of Vertebrates a class of animals that seem really to occupy an apical position in a certain line of development. The Chætopods seem to be so highly specialised, that we must be suspicious of taking them to be the origin of another great group, but rather consider them as the ultimate result of evolution in a particular direction. In general it must always, *a priori*, be unsafe to attempt to make the apex of one group the base of the next; and in all cases it must be better, and more consonant with the principles of evolution, to search for the closest relations of one group among the simpler and less specialised members of another. A. E. S.

THE ROYAL SOCIETY OF CANADA

THE annual meeting of this Society was held at Ottawa, May 21-24, under the presidency of the Hon. P. J. O. Chauveau, LL.D., D.-ès-L.

The following papers were read in Section III. (Mathematical, Physical, and Chemical Sciences):—Electrical induction in underground and aërial metallic conductors, by F. N. Gisborne, C.E. The author proposed, in order to get rid of induction phenomena in telephone circuits, to connect sending and receiving telephones by means of pairs of twisted and insulated wires. He described experiments made with a section of cable about 3000 feet in length and laid underground between two of the Departmental Buildings at Ottawa. The cable contained twenty indifferently insulated wires, which were divided into pairs, two wires being twisted together in each case, each pair constituting a metallic circuit, and one wire of each pair being used as a "return" instead of the earth plates usually employed. The experiments showed that if one of these pairs was used as a telephonic circuit, no induction effects could be observed in the others. The absence of induction effect he attributed to the equidistance of the two wires of a pair from any third wire and the equality and opposition of the currents flowing in them.—A particular case of the hydraulic ram or water hammer, by C. Baillargè, C.E.—On the form of the contracted liquid vein affecting the present theory of the science of hydraulics, by R. Steckel. Communicated by C. Baillargè, C.E.—The origin of crystalline rocks, by T. Sterry Hunt, LL.D., F.R.S. The author began by remarking that the problem of the origin of those rocks, both stratified and unstratified, which are made up chiefly of crystalline silicates, is essentially a chemical one. He then proceeded to review the history of the once famous dispute between the vulcanist and the neptunist schools in geology as to whether granite and other crystalline rocks were formed by igneous or by aqueous agencies, and showed from recent writers that the controversy is not yet settled. He noticed of the igneous school both the plutonic and the volcanic hypotheses of the origin of these rocks, and then considered the so-called metamorphic and metasomatic hypotheses, which would derive them by supposed chemical changes from materials either of igneous or of aqueous origin. The hypothesis of Werner was next discussed. This conceives all such rocks to have been successively deposited in a crystalline form from a chaotic watery liquid, which surrounded the primitive earth, and at an early time held in solution the whole of the materials of these rocks. The inadequacy of all of these hypotheses was pointed out, though it would appear that Werner's was the one nearest the truth. The author conceives that the crystalline rocks were formed by deposition from waters which successively dissolved and brought from subterranean sources the mineral elements. Their formation is illustrated by that of granitic veins, and that of zeolites—processes regarded as survivals of that which produced the earlier rocks. The true zeolites are but hydrated feldspars, while the minerals of the pectolitic group correspond to the protoxyd-silicates of the ancient rocks. The source of the elements in these rocks, according to the new hypothesis here proposed, was in the superficial layer which was the last-congealed portion of an igneous globe consolidating from the centre. In this primitive stratum, porous from contraction and impregnated with water, resting upon a heated anhydrous nucleus, and cooled by radiation, an aqueous circulation would be set up, giving rise to mineral springs. The waters of these dissolved and brought to the surface, there to be deposited, the quartz, the feldspars, and other mineral silicates, which, through successive ages, built up the great groups of crystalline stratified rocks, often so markedly concretionary in aspect. Exposed portions of the primitive silicated material would be subject to atmospheric decay and disintegration, giving rise to sediments of superficial origin, which would become intercalated with the deposits from subterranean sources. The reactions between the mineral solutions from below and the superficial materials were important in this connection, probably giving rise to certain common micaceous minerals; while dissolved silicates allied to pectolite, by their reaction with the magnesian salts, which then passed into the ocean waters, generated species like serpentine and pyroxene. This process of continued upward lixiviation of the primitive chaotic stratum would result in the production of a great overlying body of stratified acidic rocks, leaving below a basic residual and much diminished portion, the natural contraction of which would cause corrugations of the superincumbent stratified mass, such as are everywhere seen in these ancient rocks. The source of volcanic rocks is partly in this lower and more or less exhausted stratum of comparatively insoluble and basic ferriferous silicates, whence come melaphyres and basalts; partly in the secondary or acidic mass, which, softened by the combined agency of water and heat, may give rise to granitic and trachytic rocks; and partly also, it is conceived, in later aqueous deposits of superficial origin, which also may be brought within the influence of the central heat. This attempt to explain the genesis of crystalline rocks by the continued solvent action of subterranean waters on a primitive stratum of igneous origin the author designates the crenitic hypothesis, from the Greek κρήνη, *fons*. A preliminary statement of it was made by him to the National Academy of Sciences at Washington, April 15, 1884, and appears in the *American Naturalist* for June.—On the density and thermal expansion of aqueous solutions of copper sulphate, by Prof. J. G. MacGregor, D.Sc. The author gave the results of extended observations of the density of solutions of different concentration and at different temperatures. They show that the rate of variation of density with temperature increases with the temperature and with the percentage of salt in solution; that the density of any solution at low temperatures (below 20° C.) diminishes, as the temperature increases at a greater rate than that of water; that the ratio of the density of a solution to the density of water at the same temperature diminishes as the temperature increases; and certainly for many solutions, probably for all, attains a constant value within the temperature limits of the experiments (below 35°-50°); that, therefore, at about 40° C. the thermal expansion of solutions is the same as that of water at the same temperature. The experiments also substantiated a result formerly reached by Prof. Ewing and the author that very weak solutions of this salt have a smaller volume than the water used in making them. If then these solutions are made by the addition of anhydrous salt to water contraction must occur. The experiments show that the greatest contraction occurs in the case of a solution containing 1·34 per cent. of anhydrous salt, in which case the contraction is 0·0048. The solution containing 5·95 per cent. of anhydrous salt has the same volume as the water required to make it.—Blowpipe reactions in plaster of Paris tablets, by Prof. E. Haanel, Ph.D. This paper was a continuation of that presented to the Society last year. The author described the result of the treatment of copper with hydrobromic acid, and of iron and

selenide of mercury with hydriodic acid. He held the range of coatings *per se* for those tablets to be greater than for any other support used in blowpipe analysis, and described these coatings for selenium, tiemannite, arsenic, silver, alloys of bismuth, antimony, and lead with silver, galena, orpiment, realgar, mercury, tellurium, carbon, cadmium, and gold.—Description of an apparatus for distinguishing flame-colouring constituents when occurring together in an assay, by Prof. E. Haanel, Ph.D. The apparatus consists of a spectacle frame furnished for the left eye with plain colourless glass, and for the right eye with four glasses—red, green, violet, and blue. These glasses revolve on an axis, and can be brought either separately or in any combination before the eye of the operator.—"Essai sur la Constitution atomique de la Matière," by the Very Rev. T. E. Hamel, D.D.—The algebraical development of certain functions, by Prof. N. F. Dupuis, M.A.—Contributions to our knowledge of the iron ores of Ontario, by Prof. E. J. Chapman, Ph.D., LL.D. The paper contained a series of analyses of magnetic and other iron ores from samples obtained personally by the author from various parts of Ontario. The geological conditions of the deposits are also briefly given.—"Note sur une fait météorologique particulier à Quebec," by Rev. Prof. J. C. K. Laflamme, D.D.

Section IV. (Geological and Biological Sciences).—The following papers were read:—Note of observations in 1883 on the geology of a part of the north shore of Lake Superior, by A. R. C. Selwyn, LL.D., F.R.S. In these observations the author considered he was able to show that the great masses of columnar trap which form the summit of Thunder Cape, Pic Island, and McKay's Mountain were not part of a "crowning overflow," as they have been described to be, and newer than the Keweenian series, but that they are contemporaneous with the black slaty shales of the Animikie series, which immediately and conformably underlie them.—Revision of the Canadian Ranunculaceæ, by Prof. George Lawson, Ph.D. LL.D. (Halifax, N.S.). The author referred to his "Monograph of Ranunculaceæ," published in 1870, to the extensive collections that had been subsequently made, and to works published upon the North American flora, all of which enabled a fuller and more accurate description of Canadian ranunculaceous plants to be given now than was possible when the previous paper was prepared. The greater precision given to recent observation had also enabled the geographical range of these plants to be stated more fully. The striking diversity of modification in the form, number, and arrangement of the several parts of the flower and of the fruit in the several genera was pointed out. The number of Canadian species is 78 and of varieties 18: viz. Clematis 4, Anemone 14, Thalictrum 6, Ranunculus 29, Myosurus 2, Pæonia 1, Caltha 3, Trollius 1, Coptis 2, Aquilegia 2, Delphinium 5, Aconitum 2, Hydrastis 1, Actæa 2, Cimicifuga 1, Trautvetteria 1.—Geology and geological work in the Old World in their relation to Canada, by Principal Dawson, C.M.G., LL.D., F.R.S.—The Taconic question in geology, part 2, by T. Sterry Hunt, LL.D., F.R.S. The writer having given in the *Transactions* of the Royal Society of Canada for 1883 the first part of this paper, it remains in the second and last part to show, in the first place, more fully than has yet been done, the relations of the Taconian or Lower Taconic series of stratified rocks to the succeeding Cambrian or Upper Taconic, which some geologists have confounded with the Taconian. In this connection is given a critical discussion of the studies of Perry, Marcou, and others, and the opinions of Dana as regards the Cambrian of the Appalachian region of North America. In the second place is considered the probable equivalence of the Taconian to the Itacolumite series of Brazil and to similar rocks elsewhere in South America and the West Indian Islands, as well as in Hindostan and Southern Europe. All of these comparative studies, it is said, tend to establish the distinctness of the Taconian as a great and widely-spread series of crystalline stratified rocks occupying a horizon between the Cambrian and Montalban or younger gneiss series of Europe and North America.—Note on the occurrence of certain butterflies in Canada, by W. Saunders, London, Ontario. *Papilio cresphontes*, once a rare butterfly in Ontario, is now widely disseminated throughout that province. In the Southern United States its larvæ feed on the leaves of the orange and lemon, but in Canada they appear to thrive upon the foliage of such members of the *Rutaceæ* as *Xanthoxylon*, *Ptelea*, *Ruta*, and *Dictamnus*. *Papilio philenor* is also extremely rare in Canada, but a large flock of this species was observed by the Rev. C. J. S. Bethune near Woodstock, Ontario, in 1858. The writer also recorded the capture of *Terias mexicana* and *Thecla smilacis* at Point Pelée, Ontario, in 1882, and concluded by remarking that twenty-three years ago he had taken two specimens of a new species of *Thecla* at London, Ontario, which has since been described by Mr. W. H. Edwards as *T. leta*.—On some deposits of titaniferous iron ore in the counties of Haliburton and Hastings, Ontario, by Prof. E. J. Chapman, Ph.D. This paper, after referring to the occurrence of numerous deposits of magnetic iron ore in certain zones or belts of country in the counties of Victoria, Haliburton, Peterborough, and Hastings, describes their conditions of occurrence as those of large isolated masses or "stocks," forming in some cases "sheathed stocks," or *Stockscheiders* and *Skölars* of German and Swedish miners, as in the great iron ore zone of Arendal in Norway. Whilst these stock-masses of iron ore are for the greater part quite free from titanium, one of vast size in the township of Glamorgan, and another equally large mass in Tudor, are shown to contain a considerable amount of titanium. Detailed descriptions of these are given, with analysis of the ore by the writer.—On mimetism in inorganic nature, by Prof. E. J. Chapman, Ph.D. Mimetism—as recognised in organic nature—has been regarded on the one hand as the direct result of a protecting Providence, and, on the other, as originating in minute approaches towards the imitated object, these becoming intensified in successive generations until the imitation becomes complete or reaches its extreme limit. In this paper the writer attempts to show that neither hypothesis may be absolutely correct, but that the peculiarity may be due to some occult law of "localism" by which associated forms often become impressed with mutual resemblances. In support of this view he refers to several curious cases in which certain minerals, normally and generally of very dissimilar aspect, become closely mimetic under certain local conditions, as seen in examples of quartz and zircon, pyroxene and apatite, &c., in the phosphate deposits of the Ottawa region.—A monograph of Canadian ferns, by Dr. T. J. W. Burgess and Prof. J. Maconn, M.A., F.L.S. Prof. Maconn stated that twenty years ago the total number of ferns known to occur in Canada was forty-six, while at the present time it had increased to sixty-three. In illustrating the range of the more interesting species, he particularly noticed the occurrence of *Phegopteris calcarea* in Anticosti, where he had found it in 1882, and remarked that the same plant has recently been collected by Dr. G. M. Dawson and R. Bell in the country around and to the east of the Lake of the Woods.—On geological contacts and ancient erosion in the province of New Brunswick, by Prof. L. W. Bailey, M.A., Ph.D. This paper summarises the more important and well-established lines of physical contact between the geological formations of New Brunswick, as bearing upon the relative age of the latter and the disturbances to which they have been subjected. Three well-marked breaks separating groups of widely diverse character were recognised among pre-Cambrian strata,—the supposed equivalents of Laurentian, Huronian, and possibly Montalban horizons,—a very marked one at the base of the Cambrian, and others successively between later formations to the base of the Trias. The evidence of such breaks was shown to be of various character, including discordance of dip and strike, overlap, igneous extravasations, and intermediate erosion, and the bearing of the facts determined on the physical and geological history of North-Eastern America, was briefly discussed. The granites, which constitute so marked a feature in the geology of the Acadian Provinces, were described as intrusive, and as the cause of the extensive alteration exhibited by the formation, which they have invaded. The erosion which accompanied or followed upon the disturbances described was shown to have been enormous.—Illustrations of the fauna of the St. John group. Part III. Conocoryphidæ, with notes on the Paradoxidæ, by G. F. Matthew. The species of *Conocoryphe* referred to and illustrated are *C. matthewi*, Hartt, with three varieties; *C. elegans*, Hartt; *C. baileyi*, Hartt, with two varieties, and a new form which the author describes as *C. walcotti*. Critical remarks are also made upon *Paradoxides lamellatus*, Hartt, and *P. acadicus*.—The Glacial deposits in the neighbourhood of the Bow and Belly Rivers, by Dr. G. M. Dawson, A.R.S.M.—On the geology and economic minerals of Hudson's Bay and Northern Canada, by Robert Bell, M.D., LL.D., Assistant Director of the Geological Survey of Canada. By Northern Canada the author meant the whole of the Dominion northward of the organised Provinces and Districts, as far as known. His information was derived from his own observations around Hudson's Bay and in

the North-West Territories, and from the reports and maps of the scientific men who had accompanied the various Arctic expeditions by sea and land. Specimens and interesting notes on the geology of Great Slave Lake had been received from Capt. H. P. Dawson, R.A., who had spent last year there in charge of the Canadian Station of the Circumpolar Commission. The distribution of the various formations from the oldest to the newest was illustrated by a large geologically-coloured map of the whole Dominion. Referring first to the Laurentian system, Prof. Bell showed that it forms the surface-rock over an enormous area of circular form on the main continent, and that the central part is occupied by the waters of Hudson's Bay, which are surrounded by a border of Palæozoic rocks. If we included the Laurentian rocks of Greenland and the Atlantic coast from Newfoundland to Georgia, it would be observed that their general outline corresponds with that of the continent, which has been built up around this ancient nucleus. The Huronian strata, which constitute the principal metalliferous series in Canada, were closely associated with the Laurentian, and appeared to be always conformable with them. The largest and best-known areas were between Lake Huron and James's Bay, but Dr. Bell had found four belts of them on the east coast of Hudson's Bay, and others had been recognised in the primitive region to the west of it. Indeed wherever the older crystalline rocks had been explored in Canada, belts having the character of the Huronian series had been met with. Limestones, slates, and quartzites, interstratified with amygdaloids, basalts, &c., corresponding with the Nipigon formation of Lakes Superior and Nipigon were largely developed on the Eastmain coast and adjacent islands of Hudson's Bay, and apparently also on the Coppermine River and to the westward of it. But a set of hard red siliceous conglomerates and sandstones were seen to come between the Huronian and the Nipigon series at Richmond Gulf on the Eastmain coast, which appeared to be unconformable to both. Mr. Cochrane and Dr. Bell had found similar rocks on Athabasca Lake, Capt. Dawson, R.A., on Great Slave Lake, and Sir John Richardson to the north-east of Great Bear Lake. The conglomerates, slates, and gray argillaceous quartzites of Churchill and the white fine-grained quartzite of Marble Island were probably of this horizon. Silurian rocks were well known to be widely spread on some of the largest of the Arctic islands, and along the most northern channels of the Polar Sea. They formed an irregular and interrupted border on the western side of Hudson's and James's Bays. A large basin of Devonian strata, containing gypsum and clay-ironstone, extended southward from James's Bay. West of the great Laurentian area, Devonian rocks could be traced here and there all the way from Minnesota to the mouth of the Mackenzie River. They were not, however, so widely distributed as had been supposed by the older travellers, who had passed rapidly through the country in the early part of the century, when the whole subject of American geology was in its infancy. The so-called bituminous shale of Sir John Richardson and others, so prevalent along the Athabasca and Mackenzie Rivers, was found by Prof. Bell to consist of soft Cretaceous strata, saturated and blackened by the petroleum rising out of the underlying Devonian rocks, which here, as in Ontario, Ohio, and Pennsylvania, are rich in this substance. The principal features and the geographical distribution of the Carboniferous, Liassic, Cretaceous, and Tertiary rocks of the northern regions were next described. Among other points of interest in reference to the post-Tertiary period, Dr. Bell mentioned that the remains of both the mastodon and mammoth had been found on Hudson's Bay, and that there were reports of the occurrence of elephants' tusks on an island in its northern part. Isolated discoveries of elephantine remains had been made in the North-West Territories and several on the Rat River, a tributary of the Youkon, near the borders of Alaska. In referring to the economic minerals, Prof. Bell said that even the coarser ones, such as granite, limestone, cement-stone, slate, flagstones, gypsum, clays, marls, ochres, sand for glass-making, moulding, &c., would yet have their value in different parts of the great region under consideration. Soapstone, mica, plumbago, asbestos, chromic iron, phosphate of lime, salt, pyrites, &c., had been noted in different localities. Among ornamental stones known to occur, might be mentioned the rare and beautiful mineral lazulite discovered by Dr. Bell at Churchill, also malachite, jade, agate, cornelian, chrysoprase, &c. Lignites of various qualities, some being very good, were found in many places throughout the great tract occupied by the Cretaceous and Tertiary rocks of the Athabasca-Mackenzie Valley and on the coasts and islands of the Arctic Sea; also in Tertiary strata at Cumberland Bay and in Greenland, on the opposite side of Davis' Strait. The lignites found by Dr. Bell on the Albany and Moore Rivers were of post-Tertiary age. Anthracite of fine quality had been found on Long Island in Hudson's Bay. True bituminous coal had been reported to occur on Banks' Land, Melville, and Bathurst Islands. Petroleum, which proceeded from Devonian strata as elsewhere in North America, was very abundant along the Athabasca and Mackenzie Rivers, and vast quantities of asphalt resulting from the drying up of the exuding petroleum were found on the Athabasca, around Great Slave Lake, and at various places in the interior. In reference to the metals, the ores of iron were abundant. Inexhaustible quantities of rich manganiferous carbonate of iron existed on the islands of the Manitounik chain. It lay in beds upon the surface over hundreds of square miles, and was broken up by the frost into pieces of convenient sizes for shipping. Valuable deposits of magnetic iron had been found on Athabasca and Knee Lakes, and a great bed of pure clay-ironstone on the Mattogomi River. Capt. Dawson had found a vein of specular iron on Great Slave Lake. Copper ore had been met with on Hudson's Bay and near Lake Mistassini, and large quantities of the native metal were known to occur on the Coppermine River. A band of limestone, running from Little Whale River to Richmond Gulf, was rich in galena. Zinc, molybdenum, and manganese had been found on Hudson's Bay, and antimony in the north. Both gold and silver had been detected in veins on the Eastmain coast, and alluvial gold had been washed out of the gravel and sand of the streams among the mountains in the tract to the west of the lower part of the Mackenzie River, which Dr. Bell thought might yet become the great gold and silver region of the north, corresponding with Colorado and Nevada to the south. The fine gold-dust found in the drift in one section of the North Saskatchewan may have been derived, during the Glacial period, from the upper valleys of the Liard, on one of which the famous Cassiar gold district is situated; although Dr. Bell had some years ago originated the theory that this gold might have come from Huronian rocks in the district to the north-eastward of Edmonton.—"Note sur certains dépôts aurifères de la Beauce," by the Rev. Prof. Laflamme, D.D.—"Découverte de l'émeraude au Saguenay," by the same.—Description of a supposed new Ammonite from the Upper Cretaceous rocks of Fort St. John on the Peace River, by Prof. J. F. Whiteaves, F.G.S., &c.; On a new Decapod Crustacean from the Pierre Shales of Highwood River, N.W.T., by the same. The Ammonite referred to in the first of these communications appears to be a previously undescribed species of *Prionocyclus*, closely allied to the type of that genus, the *Ammonites woolgari* of Sowerby, but with much more closely coiled volutions. It occurs in flattened nodules, in shales which are believed to be the equivalents of the Fort Benton group of the Upper Missouri section. The Decapod Crustacean from Highwood River, a tributary of the Bow, is doubtfully referred to the genus *Hoplopar:a* of McCoy.—Notes on the manganese ores of Nova Scotia, by E. Gilpin, M.A., F.G.S.—A revision of the geology of Antigonish County, Nova Scotia, by the Rev. D. Honeyman, D.C.L.—"Notes sur la constitution géologique de l'Apatite Canadienne," by S. Obalski.

THE RAINS AND THE RECENT VOLCANIC ERUPTIONS[1]

THE rains this year have been more persistent than usual. At Perpignan they have been extraordinary. Is it necessary to see any relation between this circumstance and the recent volcanic eruptions? The beautiful crepuscular colorations of the past autumn and winter have been attributed to these eruptions; ought we also to attribute to them the extraordinary spring rains? I should be inclined to believe it. It is acknowledged that the presence in the atmosphere of solid particles facilitates the condensation of vapour. This would be in conformity with the position maintained by Mr. Aitken in his paper on Dust, Fog, and Clouds (volume for 1880-81, *Trans. R.S.E.*). He concludes thus:—"In an atmosphere saturated with vapour, but free from dust, there is formed neither cloud nor fog; whenever the vapour of water is condensed in the atmosphere, it is owing to the presence of those solid particles, each of which becomes, so to speak, a centre of condensation, or the nucleus of a small crystal of ice."

[1] Paper read at the Paris Academy of Sciences by M. Gay, June 23.

Very often direct observation has shown the existence of these dusts in drops of rain, and this is what has happened in all parts of the world since the crepuscular colorations of 1883-84. The dusts collected have a composition which usually indicates a volcanic origin. It has been shown that other volcanic eruptions have been followed by red glows in the sky; it appears to me that it may also be shown that they have been followed by abundant rains. The eruptions which have been referred to are those of the Skaptar Joekull, in Iceland, in the beginning of May 1783; of a new volcano, since disappeared, in the Sicilian Sea early in July 1831; Cotopaxi, in America, in 1856; Vesuvius in 1862. These eruptions were followed by colorations; I add that they were followed by rains which exceeded the mean. The following, in millimetres, are the monthly heights of rain collected on the terrace of the Paris Observatory; the second line is the monthly mean of from twenty to thirty years:—

		May	June	July	Aug.	Sept.	
1783	... ...	62	86	43	75	51	
Means	... ...	47	49	86	47	42	
		Oct.	Nov.	Dec.	Jan. 1832		
1831	... ...	52	76	36	35		
Means	... ..	41	47	34	34		
		April	May	June	July	Aug.	Sept.
1856	... ...	51	117	49	54	54	60
Means	... ...	37	53	54	55	45	48
		Aug.	Sept.	Oct	Nov.	Dec.	
1862	... ...	52	51	73	17	42	
Means	... ...	45	48	51	36	35	

EXPERIMENTS ON THE PASSAGE OF ELECTRICITY THROUGH GASES—SKETCH OF A THEORY[1]

THE passage of electricity through gases has of late years become a very favourite subject for experimental investigation. A large number of facts have thus been accumulated, and it becomes of importance to see whether these facts throw any light on the theoretical notions which we have based on other branches of electrical inquiry.

If we have two bodies at a different electrical potential separated by a layer of air, we might imagine the air in contact with the bodies to become electrified, then move on, impelled by the electric forces, and re-establish equilibrium by giving up their charges. The passage of electricity through gases would then be similar to the diffusion of heat. But, however natural such a view would be, it is impossible to maintain it in the face of experimental facts. The experiments which I shall bring before you to-day seem to me to support, on the contrary, the idea that the passage of electricity through a gas resembles the phenomenon studied by Helmholtz under the name of electrolytic convection.

I shall avoid as much as possible all suppositions and hypotheses which cannot be put to the test of experiment; but it seems necessary to start with some assumption in order to avoid too great a vagueness in the subsequent explanations. The assumption which I shall make is this: In a gas the passage of electricity from one molecule to another is always accompanied by an interchange of the atoms composing the molecule. I shall also try to prove that many facts are easily explained by the assumption that the molecules are broken up at the negative pole.

If, in a vacuum-tube of the ordinary form, the discharge is passed at a pressure of about one millimetre, a luminosity is seen round the negative pole which is called the negative glow. A luminous tongue projects from the end of the positive pole, which I shall call the positive part of the discharge, without meaning to imply that it is charged with positive electricity. The positive part of the discharge and the negative glow are separated by a non-luminous space, which I shall call "the dark interval." The glow itself is divided into three layers, the thickness of which increases with decreasing density. Closely surrounding the electrode itself, we have in the first place a luminous layer, which on new electrodes is of a golden colour. The spectroscope shows the presence of sodium and hydrogen; the sodium is due to foreign matter deposited on the electrode, and the hydrogen is expelled by the action of the heat out of the electrode by which it had been absorbed. When the electrodes have been in use for some time, the golden colour disappears, and the spectrum belonging to the gas used is seen. The second layer is known by the name of the dark space. The third layer is the glow proper.

The theory which I shall endeavour to establish is this: That within the first layer the gaseous molecules are decomposed, that their negative parts are projected with great velocity through the dark space, that this velocity is gradually reduced by impacts within the glow, and that in the positive part of discharge the discharge takes place by diffusion except when stratifications appear.

According to the kinetic theory of gases, the molecule of mercury vapour consists of a single atom, which is incapable of vibration. Mercury has a very brilliant spectrum, which proves that the theory is incomplete in some important point. It is well known, on the other hand, that the theoretical conclusion receives support from the fact that the vapour-density of mercury vapour is anomalous. If, as is generally supposed, the molecule of the majority of gases contains two atoms, that of mercury can only contain one. If an essential part of the glow discharge is due to the breaking up of the molecules, we might expect mercury vapour to present other and much simpler phenomena than the gases with which we are generally accustomed to work. *This, indeed, is the case; for I find that, if the mercury vapour is sufficiently free from air, the discharge through it shows no negative glow, no dark spaces, and no stratifications.* At the ordinary temperature the spark does not pass through mercury vapour; but if a tube free of air, but containing mercury vapour, is heated, the discharge passes always in a continuous stream of light. It is not always quite symmetrical with respect to the two poles; and a very curious tendency of the spark is noticed, to pass at the negative pole rather from the glass out of which the electrode protrudes than from the metallic electrode itself. A brilliant sodium spectrum then appears at the point from which the spark sets out. Whenever small traces of air remain, stratifications are very apt to appear, as a mixture of air and mercury gives fine stratifications, but I have never noticed them after sufficient removal of the air.

I now pass to the description of an experiment which seems to me to be only capable of explanation by the views brought forward in this paper, and I should like therefore to consider them as crucial experiments, which have to be explained by any true theory of the discharge. As negative electrode, I use an aluminium cylinder of 5·5 cm. internal diameter and 8 cm. long. A long aluminium wire running parallel to the axis of the cylinder at a distance of about an inch formed the positive electrode. On exhaustion, the discharge at first passes as a spark in the ordinary way, but as the pressure decreases the glow gradually surrounds the whole cylinder, *with the exception of a dark strip about 2 or 3 cm. in width, directly opposite the positive wire.* The positive electrode seems, therefore, to repel the negative glow.

The following seems to me a plausible explanation of the phenomenon which I have just described. The rapid fall of potential which is observed on crossing the negative electrode suggests at once, independently of any theory that we have to deal with, the action of a condenser, for we know that no statical charge can produce a finite difference of potential at the electrode, while a double layer will produce a discontinuity. Although it may not be proved that an absolute discontinuity of potential exists at the kathode, it is yet certain that a very rapid fall occurs at that place. This is all that is necessary for the argument.

We recognise such a double layer in the case of electrolytes, but there is an essential difference in the thickness of the layer within which we must imagine that condenser action to take place. In the liquids that thickness must be very small, as is shown by the intensity of the observed polarisation currents. The positively electrified matter in every case is kept against the negative surface by a joint action of electrical and chemical forces, for it has been shown by Helmholtz that only thus can we explain a difference of potential between two bodies. It is the chemical forces which keep the electricities asunder. The gaseous molecules or atoms, however subject to their mutual encounters, and always having certain velocities, will tend to leave the surface. They are kept near the surface, however, by the electrical forces.

Suppose, now, that a positive electrode is placed near such a condenser. The resistance of the gas is so much greater than that of the metal electrode that we shall assume the whole elec-

[1] Abstract of the Bakerian Lecture. Read before the Royal Society, June 19, 1884, by Arthur Schuster, Ph.D., F.R.S.

trode to be of the same potential. The lines of force will then cut the surface at right angles, and could we assume the condenser to be infinitely thin, there would only be a normal force acting on its particles; but as the lines of force are curved, the particles not in immediate contact with the surface are acted on by a tangential force which will tend to drive them away from the positive electrode. As a steady state will only be possible when the total force is normal throughout the condenser, we arrive at the condition for the steady state that within the condenser the fall of potential must be the same for equal distances measured along the normal to the surface.

Experimental evidence speaks strongly in favour of such a conclusion. If, for instance, a thin wire is used as electrode, it is well known that the tension at the end of the wire before discharge is very much larger than anywhere else. At high pressures the discharge passes indeed from the end of the wire, but as the exhaustion proceeds, the glow gradually covers the whole wire, and the same amount of electricity flows out of equal areas situated anywhere on the wire, for the dark space which alters its width with the intensity of current is everywhere the same; this implies that the fall of potential per unit distance is the same all over the wire.

Hitherto we have only assumed a certain number of particles positively electrified in the immediate neighbourhood of the negative electrode, and we have left it altogether undecided what these particles are. But if we consider now the fact that the glow does not appear opposite the positive electrode, that is to say, that while the fall of potential is the same all over the surface the flow is stronger at some places than at others, we are driven to the conclusion that the flow does not altogether depend on the fall of potential, and we must again look for an explanation in the chemical as well as the electric forces. Wherever the fall of potential is chiefly produced by the presence of the positively electrified particles, which I now assume to be the decomposed molecules of the gas, these will help by their chemical action to decompose other molecules. Opposite the positive pole the fall of potential is principally due to nearness of that electrode; chemical forces are absent, and the molecules will not be decomposed. This is, I believe, the explanation of the dark area. And it brings with it the explanation of a large quantity of other facts, as, for instance, the one which has been so long observed and well established, that once a current is set up in the gas it requires a much smaller electromotive force to keep it going. For the discharge, according to us, will generally be introduced by a spark which must give the first supply of decomposed molecules before the continuous glow discharge can establish itself.

I may for the sake of clearness once more mention shortly the principal points of the argument.

The rapid fall of potential in the neighbourhood of the negative electrode renders the presence of positively electrified particles in its neighbourhood necessary.

If the distance through which the condenser action takes place is sensible, the positively electrified particles will be acted upon by a neighbouring positive electrode.

A steady state will be established in which the fall of potential along the normal from the surface will be everywhere the same.

As however the flow is stronger away from the positive electrode, we must conclude that other forces besides electrical forces determine the flow.

It is natural to assume that these are chemical forces: that, in other words, the positively electrified particles are the decomposed molecules, which by their presence assist the decomposition of others, and therefore the formation of the current.

Unless a flaw is detected in this line of argument, I think that the conclusion must be granted, namely, that the decomposition of the molecules at the negative electrode is essential to the formation of the glow discharge. This is really all that I endeavour to support in this paper. The rest can only be settled by further experiments. And amongst the rest I count also the primary cause which originally produces the decomposition of molecules at one pole rather than at another. It is possibly due to an electromotive force of contact between the gas and the electrodes which tends to make the gas electronegative.

The gaseous molecules, then, according to our theory, are decomposed at the negative pole. Their negative constituents can follow the electric action, and as the fall of potential in the immediate neighbourhood of the pole is very rapid, the atoms will leave the pole with considerable velocity. That the region of the dark space is filled with matter projected from the negative pole follows almost conclusively from the experiments of Goldstein and Crookes, and is also shown in a most striking way by an experiment due to Hittorf. If a tube contains two parallel wire electrodes at a distance of say a quarter of an inch, the discharge will at high pressure pass in the usual way from electrode to electrode, but at very low pressures the discharge from the positive pole goes away from the negative. The results can be shortly expressed by saying that, as far as the positive pole is concerned, the inner boundary of the dark space forms the negative electrode. If the dark space is small and does not reach to the positive pole, the discharge passes from the latter towards the negative pole, but as soon as the dark space extends beyond the positive pole, the positive part of the discharge goes towards the nearest point of the dark space that is straight away from the negative pole.

We have then two closely adjoining, almost overlapping parts, in which the discharge is in opposite directions, and this could not be unless electricity is carried by matter which can, owing to its inertia and high velocity, move against the electric forces. To my mind this experiment proves conclusively that the negative electricity is bound to matter projected with high velocity away from the negative pole.

Goldstein has shown that when a thin pencil of the negative glow belonging to one electrode passes close to another the pencil is deflected. According to our view, such a pencil would be formed by a succession of negatively charged particles projected in nearly the same direction away from the negative electrode; as these particles pass by another kathode, they are naturally deflected out of their path by the electric forces. Goldstein has shown that if the current is equally divided between the two kathodes, the deflection is independent of the intensity of the current, the pressure, and the nature of the gas. This is exactly what ought to happen according to our theory, for strengthening the current at one kathode means, as will presently appear, increasing the velocity of the particles. The square of the velocity will increase in the same ratio as the total fall of potential in the neighbourhood of the negative pole; as the particles pass the other kathode, the forces from it are increased in the same ratio as the square of the velocity with which they are moving, and consequently the path will remain the same. Similarly all the other experimental facts established by Goldstein can be easily explained.

The most conclusive proof of the view adopted in this paper would be found in the demonstration that the amount of electricity carried by each particle was always the same, whatever the current. I propose to test this fact in the following way:—It was found by Hittorf that the particles proceeding from the negative electrode, and projected at right angles to the lines of force in a magnetic field are bent round in a circle. This is as it should be, and I calculate that the radius of the circle ought to vary as $\sqrt{F}/e$, where F is the total fall of potential within the region in which the particles acquire their velocity, and e is the amount of electricity carried by each particle. As the current increases, it is shown by Hittorf that F increases; and I find that at the same time the diameter of the ring in the magnetic field increases. If this diameter varies as the square root of F, it would be proved that e must be constant as it is in electrolysis. At present we can only say that the average amount of electricity carried by the particles must increase less rapidly than the fall of potential. If e varies at all, we should expect it to vary proportionally to the fall of potential in the neighbourhood of the negative electrode, and in that case the diameter of the ring would be independent of the current, which it is not.

The theory which I advocate involves the existence of a polarisation, and it might be considered a difficulty that no polarisation currents have with certainty been observed in gases. I believe the difficulty only to be apparent, for the experiments prove that the fall of potential near the negative pole, though rapid, is not sudden, so that the layer within which the condenser action takes place is very much thicker in gases than in liquids. The capacity of the condenser is therefore smaller, and though the total fall of potential in the gas may even be stronger than in the liquid, the polarisation currents might escape observation.

With regard to the positive part of the discharge it will be sufficient here to mention that stratifications are principally observed in mixtures of gases or in compound gases, and that in

the intervals between two stratifications the discharge is very likely carried as through the dark space at the negative electrode, while in the stratifications recombination of the decomposed atoms takes place.

An interesting law has been proved by Hittorf and E. Wiedemann in the case of the unstratified discharge. Hittorf shows that the fall of potential is the same in the positive part for the same tube whatever the current. This means that the energy dissipated is proportional to the current, and not to the square of the current as in a liquid. In the latter form the proposition had previously been proved by E. Wiedemann, who has shown that the total quantity of heat generated is proportional to the total quantity of electricity which has passed through the tube, whether in a few strong sparks or many weaker ones.

These experiments seem to point to the fact that once the original velocity of the particles at the regular pole has been reduced the velocity becomes independent of the strength of the current, that is to say, that in the positive part of the current greater intensity only means a greater number of particles taking place in the discharge.

The paper also contains spectroscopic evidence as to the state of dissociation in a vacuum tube, especially in the negative glow.

The question as to how the electricity passes from the electrode to the gas is not discussed, nor is it possible at present to decide, should the theory prove true, whether the polarity of the atoms in the molecule depends on the way in which these are combined, or whether that atom takes positive polarity which happens to be nearest the negative electrode as the molecule approaches it.

In conclusion some novel influence of the magnet on the negative glow is described, and it is shown that two different effects have to be clearly distinguished. The first is an effect of the magnet on the discharge when that discharge is established, and has been sufficiently well investigated. But the second effect depends on the question from what part of the negative electrode the discharge sets out. With respect to this question we meet with many contradictory and inaccurate statements. If at any place the magnet tends to throw the glow together the temperature will be raised, and owing to this fact the current will be strengthened, which again raises the temperature. It may thus happen that a slight cause can induce the current to pass almost exclusively from one part of the negative electrode. For a detailed description the reader is referred to the paper itself and the illustrations accompanying it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. ANDREW GRAY, M.A., assistant to Sir William Thomson in the Natural Philosophy department of the University of Glasgow, has been appointed to the Chair of Physics in North Wales University College. Dr. J. J. Dobbie, M.A., formerly "Clark" Fellow in Natural Science, has been elected to the Chair of Chemistry and Geology.

THE following is a list of prizes, scholarships, associateships, &c., awarded at the Normal School of Science and Royal School of Mines, South Kensington, June 1884:—First Year Scholarships: Albert G. Hadcock; Fred. Carrodus; William C. Rowden; Thomas Rose. Second Year Scholarships:—George Gibbens; Isaac T. Walls. "Edward Forbes" Medal and prize of books for biology, Thomas Johnson; "Murchison" Medal and prize of books for geology, Martin F. Woodward; "Tyndall" prize of books for physics, course 1, Isaac T. Walls; "De la Beche" Medal for mining, Herbert W. Hughes; "Bessemer" Medal, with prize of books from Prof. Chandler Roberts for metallurgy, (1) Percy Bosworth-Smith, (2) William F. Grace; "Hodgkinson" prizes for chemistry, (1st, books, &c.) George T. Holloway; (2nd) Stephen J. Elliott and William P. Wynne. Associateships in Normal School of Science: chemistry, 1st class, George T. Holloway, William P. Wynne, and Elizabeth Healey; physics, 1st class, Benjamin Illingworth and Alfred Howard; biology, 2nd class, and geology 2nd class, Joseph Lomas. Associateships in Royal School of Mines: mining, 1st class, Herbert W. Hughes; mining, 2nd class, and metallurgy, 1st class, George H. Schröder; metallurgy, 1st class, Percy Bosworth-Smith, Alfred Sutton, Henry G. Graves, and Harry J. Chaney; metallurgy, 2nd class, William F. Fremersdorf and Erskine H. B. Stephenson.

SCIENTIFIC SERIALS

American Journal of Science, June.—On the tendency of rivers flowing to the north or to the south to encroach on their east or west banks respectively, by G. K. Gilbert. The author, after further study, here finally adopts the view that this tendency is sufficiently accounted for by terrestrial rotation.—Examination of Mr. Alfred R. Wallace's "Modification of the Physical Theory of Secular Changes of Climate," part ii., geological and palæontological facts in relation to Mr. Wallace's modification of the theory, by Dr. James Croll.—Description of a new fossil marsupial from the Miocene deposits of Chalk Bluffs, Colorado, by W. B. Scott. This opossum, which the author names *Didelphys pygmæa*, is intermediate in size between the *D. murina* and *D. elegans* of South America. It establishes the fact that the small insectivorous opossums now characteristic of South America existed in Miocene times in North America, and is additional evidence that the latter continent is the source from which the former received the greater part of its fauna.—On a method of obtaining autographic records of the free vibrations of a tuning-fork, and on the autographic recording of beats (five illustrations), by Alfred G. Compton.—Notes on the volcanic rocks of the Great Basin, stretching for over 400 miles from the Sierra Nevada eastwards to the western base of the Wahsatch Range, by Arnold Hague and Joseph P. Iddings. In this region the association of andesites and trachytes, or trachytes and rhyolites, is unknown, and the authors infer that trachytes occupy a far more restricted position among volcanic rocks than has hitherto been generally supposed. They also consider that the geological independence of rhyolite and trachyte is now clearly established.—Transition from the copper-bearing series to the Potsdam in the St. Croix River Basin, Wisconsin, by L. C. Wooster.—On the expression of electrical resistance in terms of a velocity, by Francis E. Nipher.—Lateral astronomical refraction, by J. M. Schaeberle. The author proposes a simple remedy for the errors in astronomical observations arising from the assumption that all atmospheric layers of the same density over any given locality are parallel to the horizon.—Description of a remarkable variety of kaolinite from the National Belle Mine, Red Mountain, Ouray County, Colorado (three illustrations), by Richard C. Hills.—The influence of convection on glaciation, by Geo. F. Becker.—Description of a new Dinichthys (*D. minor*) from the Portage Group of Western New York (two illustrations), by Eugene K. S. Ringueberg. This specimen differs in several important respects from the two Ohio species *D. Herzeri* and *D. Terrelli*, Newb.—Mineralogical notes on allanite, apatite, and tysonite (two illustrations), by Edward S. Dana.

Revue d'Anthropologie, tome vii. fasc. 2, Paris, 1884.—On the weight of the cerebellum and the hemispheres according to Broca's mode of registration, by Dr. Philippe Rey, who has been commissioned by M. Topinard to continue the comparative tables and determinations which had already served as the basis of the memoir drawn up by the latter on the weight of the brain. Bicêtre, Saint-Antoine, La Pitié, and La Salpêtrière are the sources whence Dr. Rey has derived the requisite data for his work, and his conclusions must therefore be regarded as having more of a special than a general interest, since they are exclusively based on observations of the particular classes of persons confined in these institutions.—Study of primitive peoples, as the Kaffirs, and more especially the Zulus, by Élie Reclus. This paper presents little interest or novelty for English readers, as it consists almost entirely of extracts from English travellers and missionaries, and neither opens up new sources of information nor throws any novel light on the ethnography of the nations of whom it principally treats.—On the Kalmuks, by M. Deniker. In this second part of his memoir the author, after completing his description of the anatomical and physiological characters of the Kalmuk race, which he shows to be generally brachycephalic, supplies much important information regarding their present social and political condition under the influence of Russian domination. It would appear that the people have considerable mental capacity, various young Kalmuks having taken good places in the examinations of the University of Astrakan, and officiating creditably as medical practitioners, and as directors of the hospitals which the Russians are establishing for the benefit of the tribes. The change from a nomadic to a stationary life seems, however, to have been productive of decided injury, the census of 1869 howing a diminution of 22 per cent. in the population since 1862. According to the author, this diminution principally affects females, while this census presents, moreover, the singular

feature that male births are in excess of those of the opposite sex in the proportion of 139 to 100. It is conjectured, however, that this estimate may be incorrect, and due to the fact that women and female children are regarded as of little importance, on which account their numbers may not always be taken with exactitude. There would, on the other hand, appear to be no doubt of the fatal influences on the Mogul of the change from an easy, inactive, nomad life to that followed in a settled community, in which the struggle for existence has to be carried on under the pressure of continuous if not hard labour and fixed regulations.—On the so-called "xyphoid" angle, by M. Charpy. By this term the author designates the angle comprised between the edges of the xyphoid depression of the thorax, while his paper is devoted to the consideration of the extent to which its general inferiority in women may be due to the pressure exerted by corsets, and how far it depends on physiological causes and pathological conditions.

Bulletins de la Société d'Anthropologie de Paris, tome vii. fasc. 1, 1884.—This number, as is usual with the first of the series for the year, gives the various rules and reports of the Society, with a list of its members and associates, and the presentations made to it in the preceding year, together with the opening address of the president, M. Hamy. The remaining contents are:—A report, by M. de Mortillet, of the finds at Marcilly-sur-Eure, between Dreux and Évreux, where, in a red argillaceous loam, laid bare by a railway cutting, a cranium has been discovered of the Neanderthal type. Near the spot are deposits containing elephant, rhinoceros, and other bones, intermingled with numerous flint splinters.—On the Celtic cemetery of the island of Thinie at Portivy, Saint-Pierre-Quileron, by M. Gaillard. In 14 of the 27 stone cists of various sizes which have escaped the destructive encroachments of the sea numerous remains have been found, some containing four bodies laid one above the other, and generally in inverse directions, and much bent. Some of the lower skeletons are admirably preserved, and all are remarkable for an extraordinary development of the occipital region and great flatness of the tibia. Flints and potsherds of the Dolmen age occur in large numbers.—On the Quaternary Equidæ, by M. André Sanson, who bases his observations on the large collection of bones found by M. Chauvet in the Charente and Dordogne.—On the supposed flint *atelier* of Moulin-de-Vent, Charente-Inférieure, by M. Léon Rejou. According to M. Rejou, we have here not only the site of a prehistoric factory of ordinary flint implements, but the spot at which was manufactured a special form of these instruments, found here in considerable numbers, which he compares to our modern gimlet, and of which he has failed to discover any specimens either in the neighbouring Robenhausian deposits, or at any of the other French flint stations.—On the prehistoric flint beds at Chelles, by M. D'Acy. The most recent finds include a molar of *Elephas primigenius*, which thus confirm the hitherto contested view that this mammoth form must be included in the fauna of the Chelles beds, from which M. Gaudry had moreover already obtained three similar teeth.—On the so-called "Viens-Viens" of St. Domingo, by Dr. Dehoux, who believes that these, and other wild tribes of the Antilles, are the degraded representatives of mixed breeds, and not the descendants of primitive Indians.—On a placental anomaly, by Dr. E. Verrier, with illustrations of several other analogous abnormalities suggestive of the influence of atavism in the human subject.—On the races of the Philippine Islands, by Dr. Montano, with anthropometric tables. The author discovered traces both in ancient and recent skulls of the artificial cutting away of parts of the teeth practised in the archipelago, but he has not met in the living subject with evidence of the maxillary and other lesions, believed, according to various authorities, to result from this practice.—On a case of scaphocephalus observed in the living subject, by Dr. Delisle, with comparative tables.—On the Toltecs and their migrations, by M. Charnay.—On the Botocudos and Purys of the forests of Rio Janeiro, by Dr. P. Rey, with a vocabulary of their commonest words.—Contributions towards the ethnography of the Fuegians, by Dr. Hyades, member of the French Mission to Cape Horn. This paper is supplemented by a vocabulary and grammar drawn up by Mr. Bridges of the South American Missionary Society, whose papers on the manners and customs of the Fuegians from "A Voice for South America," vol. xiii. 1866, is also given *in extenso* by the author.—On the use of iron in Egypt, by M. Soldi; and on the antiquity of the knowledge and use of this metal by the Egyptians, by M. Beauregard. In the former of these papers the author attempts to show that stone implements were generally used in the preliminary labour of cutting blocks for statuary, and iron tools only for completing the final processes of sculpture. M. Beauregard, in his paper, deals, on the other hand, with the chronological bearings of the question, and considers at length the precise meaning of the various hieroglyphics supposed to indicate this metal.—On the rational and methodic process of deducing proportional means, more especially in reference to the general mortality of France, by Dr. Arthur Chervin. The author explains the methods employed by him for the categorical grouping of diseases as shown in his "Géographie médicale de la France."

Sitzungsberichte der Naturforschenden Gesellschaft, Leipzig, 1883.—In a paper on the "Petrographic composition and structural relations of the Leipzig Graywacke," Dr. Saur confirmed the previous conclusion of Geinitz, that the rocks cropping out in the diluvial of the Leipzig district belong to the North Saxon Graywacke system, which appears to be partly Cambrian, partly Lower Silurian.—A comprehensive memoir on the German slugs was read by Dr. Simroth, who divided this family into two groups: ARION, with three species (*hortensis*, *subfuscus*, and *empiricorum*); and LIMAX, with four subdivisions (*Limax* proper, *L. lævis*, *L. agrestis*, and *Amalia*). In a second memoir the author dealt specially with the question of hermaphroditism and differentiation of sex in *Limax lævis*.—A paper on the development of the tissues and histological system of the mammalians, by Prof. Rauber, recognises two fundamental types with possible transitional forms: (1) the type characterised by invagination of the embryoplastic pole of the germ cell (mouse, rat, guinea-pig); (2) the more general type marked by absence of invagination.—In an essay on the northern Silurian erratic boulders of the Leipzig district, Dr. Felix traces these rocks ultimately to South Sweden, Bornholm, Gotland, and especially Schonen.—A recent visit to the Brunswick Anatomical Museum suggests some interesting remarks to Dr. Hennig on the subject of malformations of the female pelvis in early life.—A paper by Dr. Rauber, on the influence of temperature, atmospheric temperature, and various elementary substances on the development of the animal ovum, aims especially at a more exact knowledge of the inner properties of the embryo. The subject is treated under two heads: (1) the power possessed by germs in various stages of resisting outward influences; (2) their plastic capacity, or power of adapting themselves by changes and modifications of all sorts to changed outward conditions. In a second paper the author reports the results of researches on the influence of increased or diminished proportions of saline solutions on Mollusks, Crustacea, Hydræ, and other aquatic fauna. His experiments point at the conclusion that the primæval oceanic waters must have always been saline.—In a memoir on the tin ores of the Eibenstock granitic system and their origin, Dr. Schröder infers that the tin ores resting on the turmaline granites of Eibenstock have been exposed by the weathering of the associated rocks. The same conclusion is arrived at by Dr. F. Schalch respecting a new variety of strontianite discovered at Wildenau, near Schwarzenberg, in the Erzgebirge.—Some remarks on the traces of glacial action on the porphyry rocks of Wildschütz near Eilenburg, Saxony, were submitted by Dr. Dalmer, who pointed out that the striæ ran in two different directions, the older and normal from north-west to south-east, the more recent exceptionally between 60° N. and 80° E.—Dr. A. Sauer presented an exhaustive analysis of some specimens of the ashes from the Krakatoa eruption of last year. The material appeared to be a lava evidently of the augite-andesite family, closely related in structure to that of Turrialba in Costa Rica.—Dr. R. Sachsse reported on a new chlorophyll dye of a yellowish-brown colour, easily soluble in alcohol. The formula of this dye, which he names β-phæochlorophyll, is $C_{24}H_{33}N_3O_4$. In another paper he gave a chemical analysis of the feldspar present in the gabbro rocks of Rosswein, Saxony, which appeared to be closely allied in structure to true labradorite.

La Belgique horticole for October–December 1883 devotes a large portion of its space to a list of ornamental plants described or figured in Belgian or foreign journals, or in gardeners' catalogues, or exhibited in London, in 1882. The list comprises the large number of 251 species, of which 163 are Monocotyledons, and 105 belong to the single order of Orchideæ. The names are followed by very short descriptions.—There are also in the magazine a number of short notes of interest to floriculturists, the conclusion of an article

on the botanical discoveries of M. Roezl in America, and two fine coloured plates of *Cypripedium Spicerianum*, and *Aphelandra Margaritæ*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 19.—"The Influence of Stress and Strain on the Physical Properties of Matter."[1] Part I. Moduli of Elasticity—*continued*. Relations between Moduli of Elasticity, Thermal Capacity, and other Physical Constants. By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

The thermal capacity of each of the wires already used for the experiments on moduli of elasticity and electrical conductivity described in Parts I. and II. of this paper[2] was determined.

Every precaution was taken both with regard to the instruments themselves and the mode of using them to avoid error, and the formulæ given below may be received with great confidence.

Metal	Density at 20°C., density of water at 4°C. = 1	Formulæ for the number of thermal units required to raise the temperature of unit mass from 0° C. to t° C. Thermal capacity of water at 0° C. = 1.	Thermal capacity per unit mass at t° C.
Aluminium ...	2·731	$\cdot20700t + \cdot000152t^2$	$\cdot20700 + \cdot0002304t$
Iron	7·759	$\cdot10601t + \cdot0000701t^2$	$\cdot10601 + \cdot0001402t$
German-silver .	8·632	$\cdot09411t + \cdot0000053t^2$	$\cdot09411 + \cdot0000106t$
Zinc	7·138	$\cdot09009t + \cdot0000374t^2$	$\cdot09009 + \cdot0000748t$
Copper	8·851	$\cdot09008t + \cdot0000324t^2$	$\cdot09008 + \cdot0000648t$
Silver	10·464	$\cdot05466t + \cdot0000218t^2$	$\cdot05466 + \cdot0000436t$
Tin	7·264	$\cdot05231t + \cdot0000361t^2$	$\cdot05231 + \cdot0000722t$
Platinum-silver	12·616	$\cdot04726t + \cdot0000138t^2$	$\cdot04726 + \cdot0000276t$
Platinum ...	21·309	$\cdot03198t + \cdot0000063t^2$	$\cdot03198 + \cdot0000125t$
Lead	11·193	$\cdot02998t + \cdot0000153t^2$	$\cdot02998 + \cdot0000306t$

It will be seen that the thermal capacity of all the metals examined increased with the temperature, a result which we find confirmed by the observations of other investigators.

The thermal capacities of the alloys platinum-silver and German-silver are, within the limits of error, exactly the same as those calculated from the proportions of their components. Thermal capacity is, therefore, a physical property which is not likely to be altered to any appreciable extent by small impurities, so that the results obtained by different experimenters agree very closely with each other.

It has been proved[3] that if e be taken to denote "Young's Modulus," and α the mean distance between the centres of two adjacent molecules, $e \times \alpha^7$ is in the case of most metals approximately a constant. From this it would follow that the law of force proved by Maxwell in his experiments on the viscosity of gases[4] to exist between the molecules of a gas is approximately true for solids, accordingly the force between any two adjacent molecules of a solid is approximately as the fifth power of the distance between their centres. Now if we denote the atomic mass by A, the density by Δ, the thermal capacity per unit mass by C_m, and the thermal capacity per unit volume by C_v, we have the following relations:—

$$C_m \times A = \text{a constant};$$
$$C_v = \Delta \times C_m;$$
$$e \times \alpha^7 = \text{a constant};$$
$$\alpha \propto \left(\frac{A}{\Delta}\right)^{\frac{1}{7}}$$

From these relations we obtain—

$$\frac{e}{C_v^{\frac{7}{5}}} = \text{a constant};$$

or that the cube of "Young's Modulus" varies as the seventh power of the thermal capacity per unit volume. This relation was found to hold approximately not merely for the metals here examined, but also in the case of a great many substances for which the values of C_v and e have been determined by other investigators.

Still more approximately is it believed that this relation would hold good if for "Young's Modulus" the bulk-modulus of elasticity were substituted. Denoting the bulk-modulus by e_v, it was found that, within the wide limits of error to which determinations of the value of the bulk-modulus are liable to be affected—

$$\frac{e_v}{C_v^{\frac{7}{5}}} = \text{a constant}.$$

Neither of the above relations can be true for all temperatures, inasmuch as, whilst the value of e_v diminishes with rise of temperature, that of C_v increases, but at ordinary temperatures it seems that the bulk-modulus of elasticity can be calculated from the thermal capacity per unit volume by the formula—

$$e_v = 2071 \times 10^6\, C_v^{\frac{7}{5}}.$$

The thermal capacity per unit volume increases with the temperature, and the researches of Matthiessen, Fizeau, and others on the one hand, and of Kohlrausch on the other, have shown that there is a like increment in the thermal expansibility and torsionability[1] of metals. A careful comparison was made of the various increments above mentioned, and it is shown in the paper that whilst the ratio of increase per unit of expansibility with rise of temperature to corresponding value in the case of torsionability[2] is, within the limits of error of observation, unity, that in which thermal expansibility and thermal capacity are concerned is about two, so that the rate at which thermal expansibility increases with the temperature is about twice the rate at which thermal capacity increases. The rate of increase of both thermal expansibility and thermal capacity varies with the nature of the metal, being greatest for iron and least for platinum.

The so-called "real thermal capacity" of a solid may be found by dividing the thermal capacity of hydrogen per unit mass at constant volume, namely, 2·417, by the atomic mass; and this part of the capacity will be independent of the temperature. If the "real capacity" be subtracted from the total thermal capacity we obtain that part of the capacity which does vary with the temperature, and which has therefore in this paper been designated the "variable thermal capacity." The following table shows that *the rate of increase per unit of thermal expansibility is at 0° C., and therefore at any temperature, equal to the increase per unit of the "variable capacity"*:—

Metal	Rate of increase per unit at 0° C. of "variable thermal capacity" = C′	Rate of increase per unit at 0° C. of thermal expansibility = E	$\frac{E}{C'}$
Iron	·00230	·00309	1·34
Tin	·00216	·00250	1·16
Aluminium	·00197	·00215	1·09
Lead...	·00192	·00174	0·91
Copper	·00127	·00196	1·54
Zinc	·00157	·00170	1·09
Silver	·00135	·00155	1·15
Platinum	·00064	·00061	0·95

It is shown in the paper that the thermal capacity per unit mass is nearly two and a half times the "real capacity," so that only two-fifths of the whole thermal energy which we may impart to a mass of metal goes towards raising the temperature, the remaining three-fifths being expended in internal and external work. The external work is practically insensible in ordinary cases. Of the internal work, that expended against bulk-elasticity amounts in the limiting cases from 1/1,000th to 1/10,000th of the whole, and, though greater than the external work, is almost insensible; moreover, there seems to be no relationship whatever between the whole thermal capacity per unit volume and the work done against bulk-elasticity.

Raoul Pictet has concluded[3] that the amplitude of the oscillation of molecules around their positions of equilibrium may be taken as corresponding to temperature, and in the case of several metals has shown that

$$T \times \beta \times \alpha = \text{a constant},$$

[1] The original title of the paper has been altered to the above, as being more exact in expression.
[2] *Phil. Trans.* part i., 1883, p. 1.
[3] *Loc. cit.* p. 32.
[4] *Phil. Trans.* 1866, vol. cxxvi. part i.

[1] The inverse of "simple rigidity."
[2] Iron and copper are the only two metals for which the increase of torsionability with rise of temperature has been examined.
[3] NATURE, 1879, p. 356.

where T is the melting-point temperature reckoned from absolute zero, β the coefficient of linear expansion, and α proportional to the distance between the centres of adjacent molecules. From the above relation, combined with those already mentioned, we deduce

$$\frac{T \times \beta}{C_v^{\frac{1}{3}}} = \text{a constant};$$

and

$$\frac{T \times \beta}{e_v^{\frac{1}{3}}} = \text{a constant.}$$

The first of these two relations was found to hold good for ten out of twelve metals examined, but for the metals bismuth and antimony the ratio $T\beta : C_v^{\frac{1}{3}}$ is almost exactly *one-half* of the ratio obtained for the other metals. It was concluded that for most metals the melting-point temperature may be approximately calculated from the formula—

$$T = \cdot 02253 \times \frac{C_v^{\frac{1}{3}}}{\beta}.$$

Where C_v and β represent the mean thermal capacity per unit volume, and coefficient of expansion respectively between 0° C. and 100° C.

The second of the two relations was found also to approximately hold good.

In the paper will be found a full discussion of the experiments of Joule[1] and Edlund[2] on the thermal effects produced by mechanical stress in metals.

According to the researches of the latter the *observed* thermal effects of longitudinal stress on a wire is to be found by dividing the *theoretical* thermal effects by 1·61, since part of the work expended on a wire which is stressed longitudinally finds its equivalent in molecular effects which are not thermal. This view seems to be partly supported by some experiments made by the author on the viscosity of metals.

Zoological Society, June 17.—Prof. W. H. Flower, President, in the chair.—Mr. H. Seebohm exhibited and made remarks on some specimens of rare Asiatic and European birds, and called special attention to examples of a newly-discovered Russian species, *Bonasa griseiventris* (Menzbier).—Mr. Sclater exhibited the knob of the culmen of the beak of a Rough-billed Pelican (*Pelecanus*), which had been shed by the bird in the Society's Gardens last autumn; and called attention to the fact that on coming into breeding plumage again this summer the bird had grown another knob.—Mr. Sclater also called the attention of the meeting to a very singular habit of a Vasa Parrot (*Coracopsis vasa*), as observed in the Society's Gardens.—Mr. F. Holmwood gave an account of his observations on the employment of the *Remora* by native fishermen of Zanzibar for the purpose of catching turtle and large fishes.—Mr. R. Bowdler Sharpe read some further notes on the new Corsican Nuthatch (*Sitta whiteheadi*), in continuation of former communications on the same subject.—A communication was read from Dr. G. Hartlaub, in which he gave the description of a new species of Creeper of the genus *Salpornis*, discovered in Eastern Equatorial Africa by Dr. Emin Bey. The author proposed to name it (after its discoverer) *Salpornis emini*.—Prof. Flower, F.R.S., read a note on the names of two genera of Delphinidæ, which he found it necessary to change.—A communication was read from Dr. Camerano, giving a summary of the distribution of the native Batrachians in Italy.—Mr. G. A. Boulenger gave the description of a new variety of lizard of the genus *Lacerta* from South Portugal, which he proposed to describe as *Lacerta viridis*, var. *gadovii*.—A communication was read from Mr. H. O. Forbes, containing remarks on a paper by Dr. A. B. Meyer on a collection of birds from the East-Indian Archipelago, with special reference to those described by him from the Timor-Laut group of islands.—Lieut.-Col. C. Swinhoe read a paper on some new and little-known species of butterflies of the genus *Teracolus*. The author referred to and described twenty-two species, sixteen of which were new to science, and the others very rare.—A communication was read from Mr. Francis Day, F.Z.S., on the occurrence of *Lumpenus lumpetriformis* off the east coast of Scotland.—Mr. Oldfield Thomas read a paper upon the Muridæ collected by M. Constantin Jelski, near Junin, in Central Peru, during the years 1870-73. The collection consisted of ninety-two specimens, representing twelve species, mostly belonging to the genus *Hesperomys*, the nine sub-genera of which were now arranged and re-defined. One species and two varieties were described as new under the names of *Rheithrodon pictus*, *Hesperomys laticeps* var. *nitidus*, and *H. bimaculatus* var. *lepidus*.—A communication was read from Mr. W. E. Distant describing the Rynchota collected by the late Mr. W. A. Forbes on the Lower Niger. The collection contained examples of twelve species, eleven of which belonged to the Hemiptera and one to the Homoptera. Two species appeared to be undescribed.—Prof. Mivart, F.R.S., read a paper on the development of the individual and of the species as forms of instinctive action.—This meeting closes the present Session. The next Session (1884-1885) will commence in November next.

Geological Society, June 11.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Charles Edward Bainbridge, John J. Evans, William Frederick Fremersdorff, and Henry de Morgan Snell, were elected Fellows of the Society.—The following communications were read:—The range of the Palæozoic rocks beneath Northampton, by Henry John Eunson, F.G.S.—On some Zaphrentoid corals from British Devonian beds, by A. Champernowne, M.A., F.G.S.—On the internal structure of *Micrabacia coronula*, Goldf., sp., and its classificatory position, by Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., F.G.S.

Anthropological Institute, June 10.—Prof. Flower, F.R.S., president, in the chair.—A paper was read on the deme and the horde by A. W. Howitt, F.G.S., and the Rev. Lorimer Fison, M.A., in which the authors traced a close resemblance between the social structure of the Attic tribes and that of the Australian aborigines. The word horde is used to indicate a certain geographical section of an Australian community which occupies certain definite hunting-grounds. Its members are of different totems; in fact all the totems of the community may be represented in any given horde. Descent being through the mother as the general rule, the child is of its mother's totem, not of its father's, but it belongs to the horde in which it was born. So, too, the children of aliens are admitted into the exclusive organisation by virtue of a right derived from their mothers. In Attica there were also two great organisations—one based originally on locality, and another whose sole qualification was that of birth—the demotic and phratriac. Both included the free-born citizens, and therefore coincided in the aggregate, but no deme coincided with any phratria, or with any subdivision of a phratria. The naturalised alien was enrolled in one of the demes, but there could be no admission for him into a phratria; if, however, he married a free-born woman his children by her were not excluded, they were enrolled in her father's phratria, the relationship between a child and its maternal grandfather being looked upon as a very near tie of blood. Thus, making all necessary allowance for difference of culture in the two peoples, it appears that the phratriac is analogous to the social organisation in Australia, while the demotic divisions correspond to the Australian hordes.—A paper by the Rev. C. A. Gollmer, on African symbolic language, was read, in which the author described the method by which the natives of the Yoruba country send messages to one another, and communicate their wishes by a variety of tangible objects, such as shells, feathers, pepper, stones, coal, sticks, &c.

EDINBURGH

Royal Society, June 16.—Dr. Saug, Vice-President, in the chair.—The Astronomer-Royal for Scotland communicated a paper on micrometrical measures of gaseous spectra, which was accompanied by several elaborate maps of the spectra examined. The instrument used gave a dispersion of 1200 degrees. Among several curious results indicated was the fact that the spectrum of nitrogen indicates it to be a compound, while oxygen and hydrogen act as if simple substances. Prof. Smyth also gives the spectra of carbon-oxygen and carbon-hydrogen compounds.—Dr. Saug read a paper on the computation of recurring functions, by the aid of chain-fractions.—Prof. Tait communicated a note by A. H. Auglin on an extension of Euclid I. 47. Mr. Auglin showed how, by regarding equiangular and equilateral polygons described on the sides of a right-angled triangle as being composed of equal isoceles triangles the methods of Euclid's First Book might be used to prove the 47th Proposition as extended to equiangular and equilateral polygons.—W. E. Hoyle gave a paper on the Ophiuroidea of the Faroe Channel.

PARIS

Academy of Sciences, June 23.—M. Rolland, President, in the chair.—Researches on the origin and transformations of the

[1] *Phil. Trans.* 1859, vol. cxlix. p. 91.
[2] *Ann. der Phys. und Chemie*, Band cxxvi. p. 539.

nitrates universally present in the vegetable kingdom, by M. Berthelot. From his experiments the author infers that the nitrates, derived partly from the soil, partly from the atmosphere, are found chiefly in the stems of plants, varying from almost infinitesimal quantities to 15 thousandths in the potato, 28 thousandths in wheat, and even 150 thousandths in certain species of Amaranthus.—Report on the documents, published by the Minister of Public Works, connected with the mission undertaken by Lieut.-Col. Flatters to the region south of Algeria, by M. Daubrée. The object of this mission, carried out in the winter of 1880-81, was to ascertain the possibility of constructing a railway across the Sahara, between the French possessions on the Mediterranean and the Atlantic. As far as the Asiu wells, the extreme point so far reached, no serious obstacle was met, and for over 350 miles to the south of Wargla, the ground was found to be so easy that a line might be constructed to this point at an outlay of about 4000*l.* per mile.—Arithmetical commentary on a formula of Gauss (continued), by M. de Jonquières.—Report of the Suez Canal International Committee, meetings of June 16 and 19, communicated by M. de Lesseps. The Committee pronounces in favour of simply widening the Canal in preference to constructing another.—Election of Dr. Salmon as Corresponding Member for the Section of Geometry in place of the late Mr. Spottiswoode.—Report on two cases of secondary suture of the central nerve attended by rapid restoration of the functions of the nerve in the paralysed parts, by M. Tillaux. — Remarks on some phenomena of chemical occlusion: occlusion of one gas by another, by M. P. Schutzenberger.—On a new method of synthesis of nitrous organic compounds; complete synthesis of xanthine and methylxanthine, by M. Arm. Gautier.—Researches on the formation and structure of the gray embryonic substance in the spinal marrow of the higher vertebrate animals, by M. W. Vignal.—Description of the Calocoris, an insect of the genus Phytocoris, which infests the vine and young grape, by M. G. Patrigeon.—Note on a generalisation of the theory of reduced quantities, by M. Em. Barbier.—Remarks on the height and annular form of the mountains on the planet Venus, by M. P. Lamey. From a careful study of a series of designs of the planet executed at Grignon during the present year, the author infers that a perfectly circular protuberance in the southern hemi-phere, presumably a volcano, has an elevation of probably not less than seventy miles. He argues that this enormous height is in no way incompatible with the volcanic nature of the planet.—Description of a new mercurial electro-dynamometer, by M. G. Lippmann.—A study of the spheroidal state of fluids and their freezing-point under pressure, by M. J. Luvini.—Note on the glyoxalbisulphites of potassa and baryta, by M. de Forcrand.—Researches on ferricopotassic tartrate, ferric arseniate, arsenite of iron, and other colloidal sulphates of iron, by M. E. Grimaux.—A comparative study of the alcohols derived from the xylenic carburets, by M. A. Colson.—Remarks on the natural saltpetres of Chili and Peru, in connection with rubidium, cæsium, lithium, and boric acid; practical application to the beet-growing districts in the North of France, by M. Dieulafait.—Distribution of the saline substances of the grist in the various products of the corn-mill, by M. Balland.—Note on the poison of the Hymenoptera, and anatomical description of their secreting organs, by M. G. Carlet. The author concludes that the poison of these insects is always acid; that it is composed of two distinct liquids, one extremely acid, the other slightly alkaline; and that these two liquids are secreted by two special glands, the *acid* and the *alkaline* glands, which discharge their contents at the base of the gorgeret, or sheath of the sting.—On a new type of elastic fibre observed in the larva of Eristalis, by M. H. Viallanes.—On the development of the digestive tube of the Limaceæ, by M. S. Jourdain.—Note on the Geological Map of France, scale 1: 500,000, prepared by MM. G. Vasseur and L. Carez. This map, the first executed since 1842, will be completed in forty-eight sheets early next year. Several of the sheets have already gone to press.

Berlin

Physiological Society, May 30.—Dr. Falk has, in the course of an investigation of the phenomena of death by drowning, determined experimentally certain relations of the cutaneous nerves to respiration for which he claims a manifold practical importance. When rabbits are suddenly plunged into cold water of about 5°-7° C. a cramp of the expiratory muscles occurs, and respiration ceases in the position of expiration. This effect of cutaneous stimulation occurs even when the superior laryngeal nerves have been cut through. The recognised relation of the trigeminus to expiration, which manifests itself in the occurrence of sneezing upon stimulation of the nasal mucous membrane, was also confirmed in these experiments; when the face only was dipped into the cold water the expiratory cramp was very violent, whereas the sudden immersion of the hinder extremities and of the lower part of the body was inoperative, the effect not being produced till the breast and the neck were stimulated. The respiratory track of the larynx was the only part of it that was affected, when the face was not immersed, but the glottis closed completely when the trigeminus was stimulated. When the cutaneous nerves were more powerfully stimulated so that pain occurred, a violent inspiration set in. The methods of restoring persons apparently dead and still-born children to life have, according to Dr. Falk, no relation to the effect of cutaneous stimulation upon respiration; the dashing of cold water upon the chest acts upon the heart alone, and the pouring of water on the nape of the neck and back of the head acts upon the medulla oblongata.—Dr. A. Baginski, who had previously discovered the occurrence of xanthine bodies in the urine of children who were affected with nephritis, has followed up the occurrence of these substances, and has determined, by comparative examination of healthy and sick children, that xanthine occurs only in nephritis; and that the quantity of it present increases proportionately with the malignity of the attack. The circumstance that methyl xanthine resembles theobromine in its chemical composition suggested an examination of the tea, in which considerable quantities of guanine, xanthine, and hypoxanthine were detected. In the pancreas when putrefying the amount of xanthine substances were diminished, and of these guanine was the one of which, proportionally, most was destroyed by putrefaction. Next came xanthine, and hypoxanthine had the greatest powers of resisting putrefaction. The presumption that hypoxanthine would not even be destroyed by digestion was not borne out. After exhibition of hypoxanthine the quantity that occurred in the urine was not above the normal but rather a little below it. Its effect upon the heart was a very remarkable one, it occasioned much more active and energetic contractions, so that hypoxanthine may be regarded as a body which has the power of increasing the cardiac activity, and perhaps it is to this that the beneficial effect of tea-drinking may be attributed. Dr. Baginski intends to follow up the investigation of these interesting substances further.

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